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AMERICAN ENGINEER

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AMERICAN ENGINEER AND RAILROAD JOURNAL

JANUARY, 1905.

CONTENTS.

ANGUS LOCOMOTIVE & CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

II.

GENERAL CHARACTER OF THE BUILDINGS.

(*For previous article see this journal, December, 1904, p. 451.*)

The buildings are excellent throughout. They are substantial, serviceable, free from "frills" or wasteful attempts at ornamentation, and are well adapted to their purposes. The buildings, as well as their arrangement, reveal most careful engineering work. Their construction will precede their functions and interior arrangement in this description. In the following table the areas and proportions are given. No account is taken of sheds and lavatories, the latter being generally built upon the larger buildings as lean-tos.

AREAS AND PROPORTIONS.

	Sq. Ft. Area.	Percentage.
Locomotive shop	190,384	22.6
Grey iron foundry	41,724	4.9
Pattern shop	8,200	1.0
Pattern storage	7,500	.8
Car machine shop	37,440	4.4
Truck shop	35,588	4.2
Freight car shop	57,780	6.9
Wheel foundry	24,039	2.9
Frog shop	26,928	3.2
Blacksmith shop	84,082	10.0
Power house	17,976	2.1
Planing mill	63,000	7.5
Dry kilns	9,350	1.1
Cabinet and upholster shop	53,940	6.4
Passenger car shops	134,400	16.0
General stores	50,490	6.0
Total	842,821	

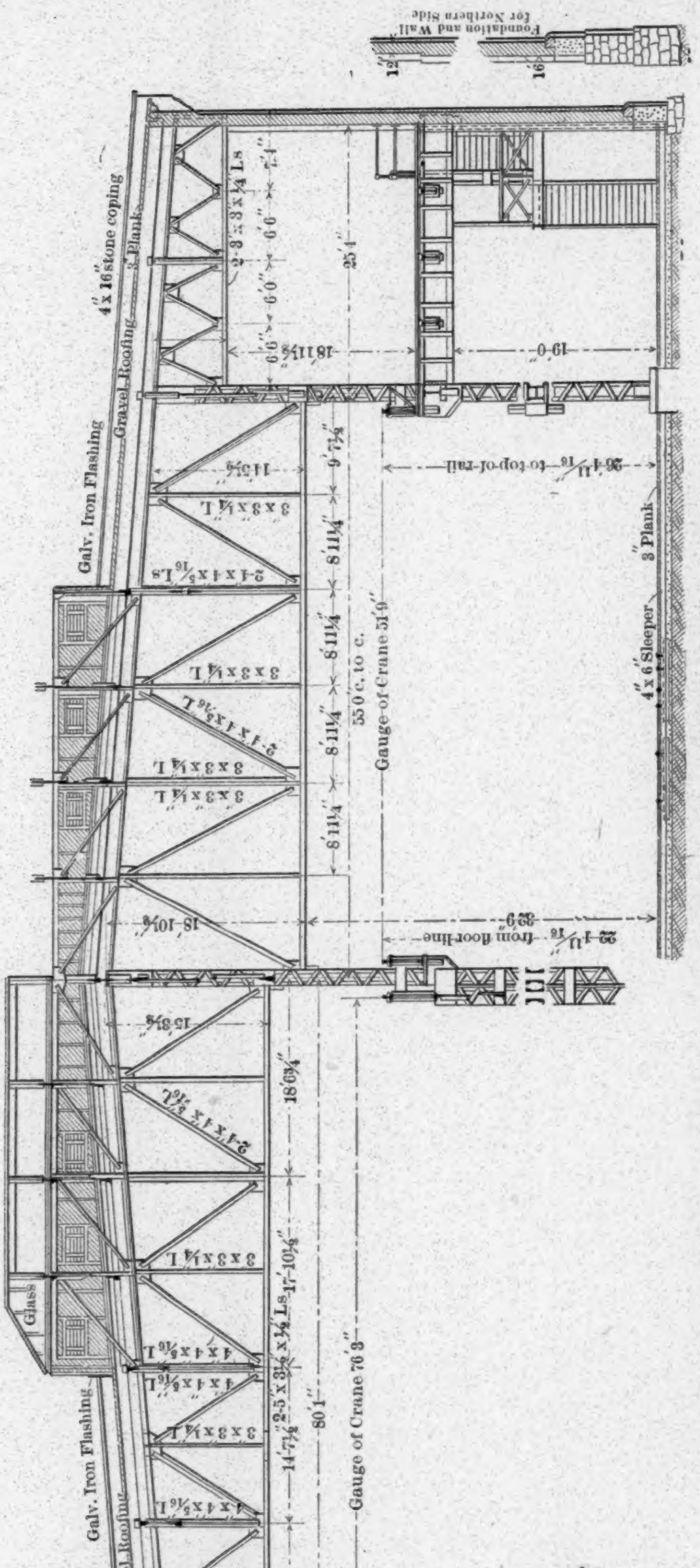
The buildings with the largest spans were built with steel trusses, but the smaller ones are of slow-burning construction, using wooden roof trusses, except in the truck shop, where a portion of the roof is supported by 20-in. I beams. Small lean-to additions have been applied to the main buildings, to provide for lavatories, shop offices and fan rooms. The shops, as a rule, are unusually well provided with natural lighting, the windows are high, and cover about half of the wall area, and the skylights about one-quarter of the roof area. The windows are all provided with 10-oz. clear glass, in 10 x 16-in. panes. The blacksmith shop and foundry buildings have clere story windows, and the other shops are, as a rule, lighted with monitors 12 ft. in width, arranged transversely, and with roofs pitched both ways, fitted with ⅜-in. rough, German, roof glass.

The foundations of nearly all of the buildings are very deep, owing to the nature of the ground, and the amount of filling which was required. About $80,000 is buried in the foundations, which are carried to rock through soft clay. Some of the foundations are 20 ft. in depth. They are built of rough, flat stone, surmounted by walls of rubble masonry 27 ins. thick, extending to within 1 ft. of the level of the ground. A course of concrete surmounts these walls, and reaches about 2 ft. above the level of the ground, finishing in a course of cut stone, upon which the brick walls are built. The walls are 12 ins. thick at the top, and from 12 to 20 ins. thick at the bottom. In nearly all cases they carry the weight of the roof. Pile foundations were used for the cabinet shop, pattern buildings, general storehouse and frog shop. All the rest are on concrete and rubble. Steel roofs are used for the blacksmith shop, the foundries, the power house and the locomotive shop. The construction of the roofs of the buildings constitute an important feature of the plant, to which adequate space cannot be given in this article. Another important feature is the large use of wood, which reflects the opinion of underwriters as favoring wood to steel for such construction. The roofs slope 1 in 12, and are built of 3-in. plank, covered with tar and gravel. They are built with 10-ft. spans, as a rule, and in accordance with the underwriters' standard specifications for slow-burning construction. Roof loads were figured at 70 lbs. per ft., allowing 50 lbs. per ft. for snow load and 20 lbs. for the roof itself. There is no exposed woodwork outside of the buildings except window and door frames.

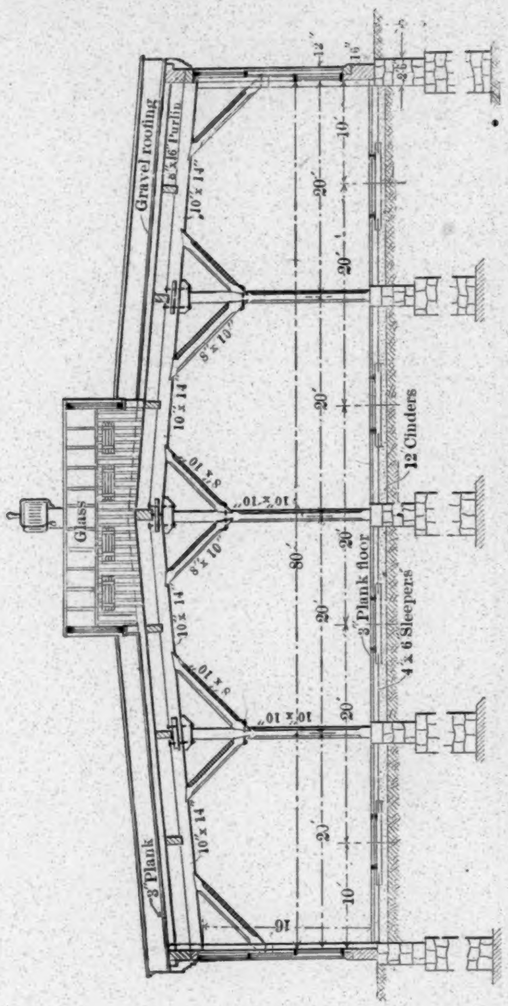
The floors are usually of concrete or cinders, tightly rammed, except those which are planked with 3 x 10-in. lumber laid on 4 x 6-in. timbers. The foundries and blacksmith shop have floors of clay and cinders, 12 ins. thick, rammed to a hard surface.

LOCOMOTIVE SHOP.—The interior of this building will receive special attention later. It is arranged in three spans, the main span of 80 ft. for the erecting floor, a span of 56 ft. for the machine shop, which is served by cranes, and a span of 25 ft. under the gallery, which extends the full length of the building. The walls of the building are 48 ft. from the ground to the eaves, and the building is divided lengthwise into panels of 22 ft., which is the distance between the roof trusses. Each space has two 12-ft. windows, 16 ft. high; the windows are in three sections, the middle of each is fixed, and the others arranged to open. Each roof panel has a transverse monitor 12 ft. wide by 72 ft. long, each having ventilating doors on each side and a rotary ventilator at each end. The steel skeleton is independent of the walls. The general character of the columns and roof trusses is shown in the engravings. The 60-ton cranes are carried on plate girders 50 ins. deep. The girders for the machine shop cranes are 36 ins. deep. The construction of the trusses of the columns for supporting the roof trusses and the crane girders is illustrated in the engravings. This building occupies 190,384 sq. ft., and 2,700 tons of structural steel were required in its construction.

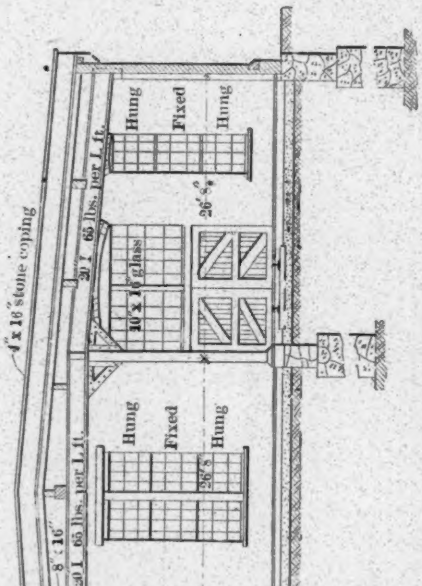
IRON FOUNDRY.—This building is 122 x 342 ft., and stands next to the locomotive shop. It has a 60-ft. main bay and two side bays of 30 ft. separated by the roof and crane columns. This is a well-lighted building, with half of the side walls lighted by windows, and the roof has a monitor 22 ft. wide, reaching nearly the entire length of the central bay. The moulding is done in the main bay, the flask and core makers, the sand, blower and tumbler rooms, the offices and cupola occupy the north bay, a coke storage bin and a heavily con-



CROSS SECTION OF LOCOMOTIVE SHOP, SHOWING ERECTING BAY AND MACHINE BAYS WITH GALLERY.

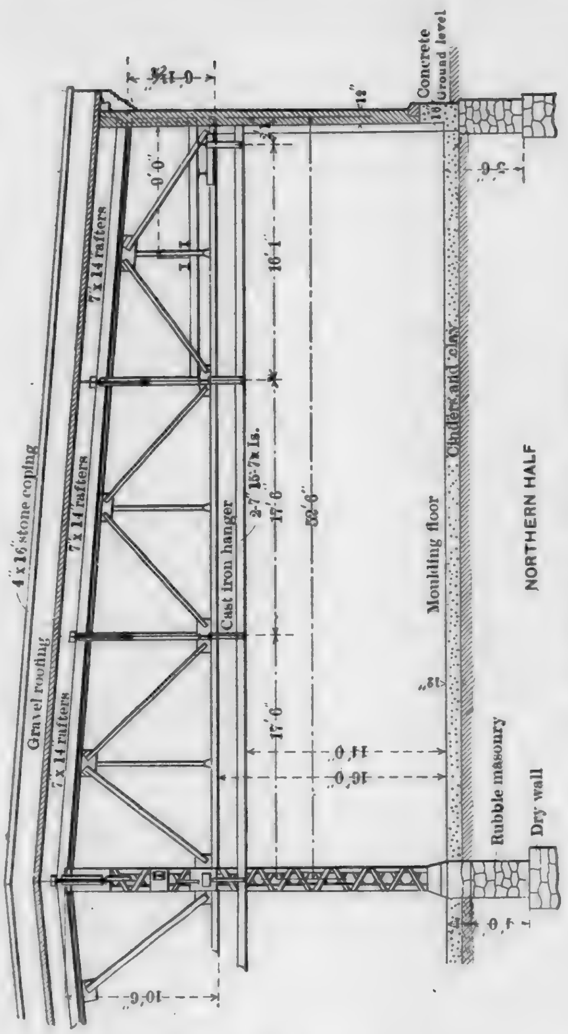


SECTION THROUGH ERECTING END OF TRUCK SHOP, SHOWING FOUR BAYS.

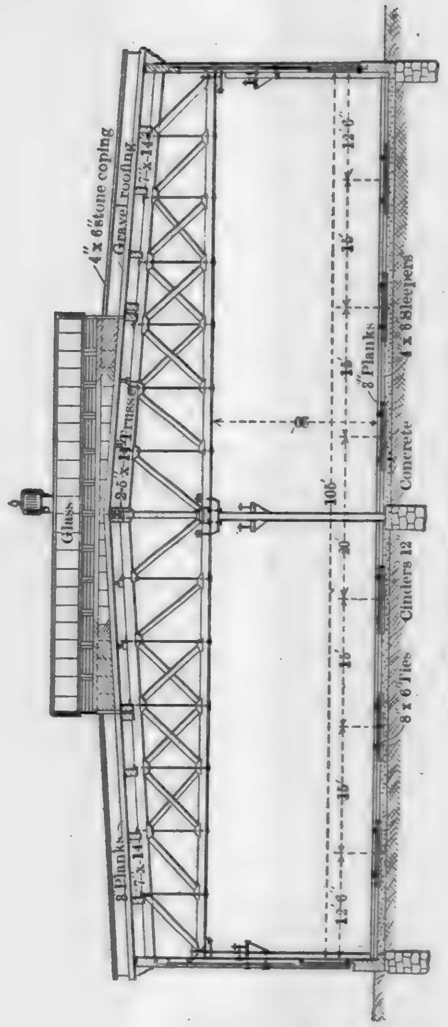


SECTION THROUGH MACHINERY END OF TRUCK SHOP.

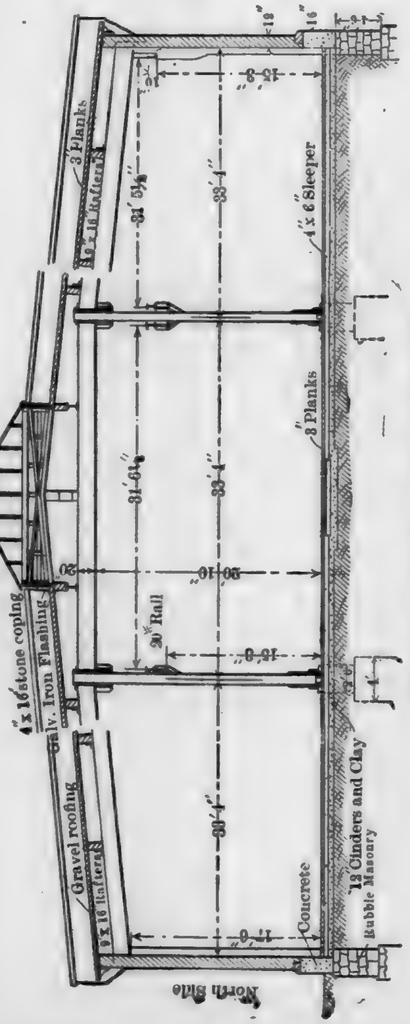
ANGUS LOCOMOTIVE AND CAR SHOPS—CANADIAN PACIFIC RAILWAY.



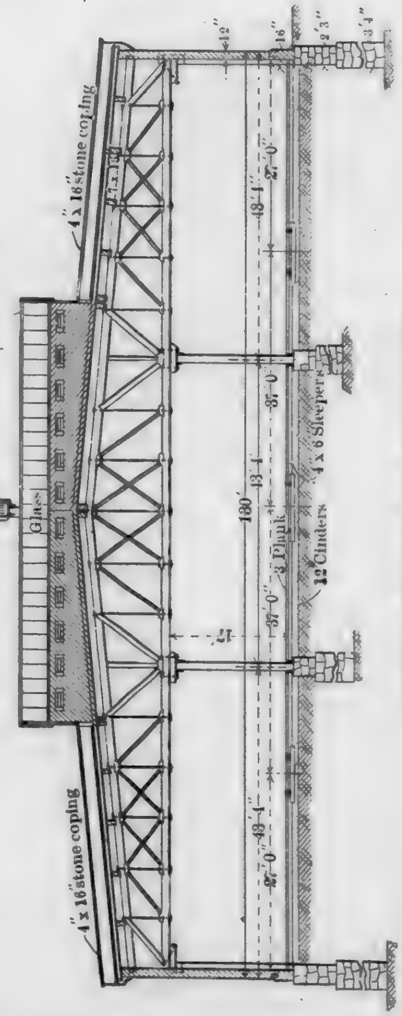
HALF-SECTION OF WHEEL FOUNDRY.



SECTION THROUGH FREIGHT CAR SHOP.



SECTION THROUGH FROG AND SWITCH SHOP.



SECTION THROUGH CAR MACHINE SHOP.

MIDWAY LOOKING SOUTH, SHOWING CRANES.

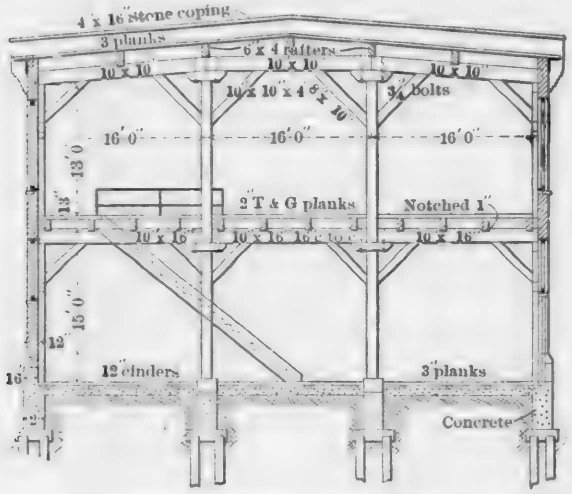
ANGUS LOCOMOTIVE AND CAR SHOPS—CANADIAN PACIFIC RAILWAY.

structed charging floor was built over the cupola room. The charging floor is reached by the out-of-door foundry crane, whereby supplies are delivered to the projecting platform.

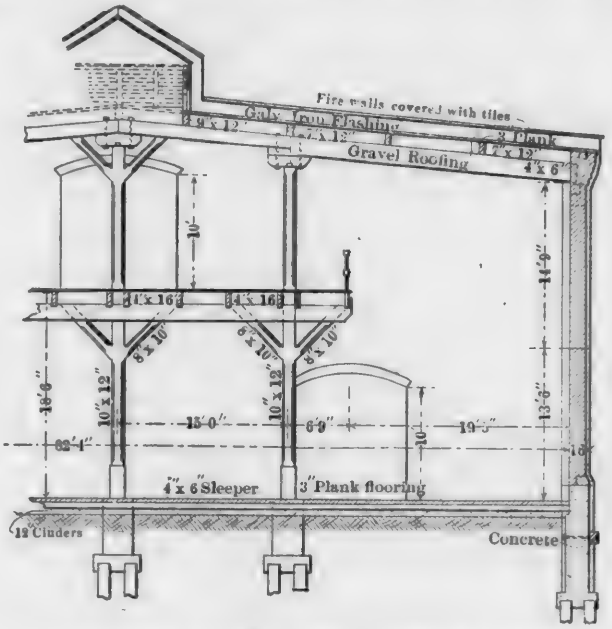
Pattern Shop.—This building has two stories, occupying a ground space of 50 x 82 ft. The building is of brick, and the roof is supported by wooden columns, dividing the floor space into three bays, as indicated in the cross section. The patterns are stored in a fireproof building of 100 x 150 ft. floor area, the roof being supported by 20-in I beams placed at 15-ft. centers, carried on the side walls and resting on a row of steel columns through the center. This building is of concrete and fireproof.

Car Machine Shop.—This building is 130 x 288 ft. and has being divided by two rows of steel columns carrying 24-in. I beams, as roof girders, at 24-ft. centers. The shop has a longitudinal track and 2-ton travelling cranes in two of the 33-ft. spans. The windows are 8½ x 15 ft., with 3-ft. spaces between, the roof being lighted by a longitudinal monitor 15 ft. in width.

Wheel Foundry.—This building is 107 x 187 ft., with two



SECTION THROUGH PATTERN SHOP.



HALF-SECTION OF STORE HOUSE, SHOWING BALCONY.

LOCOMOTIVE SHOP, SHOWING THE CHARACTER OF THE BUILDING.

three standard gauge tracks running through it. The roof trusses of this building are illustrated in the cross section. The floor is of plank, laid flush with the rails of the tracks, and built on a bed of cinders 12 ins. deep. The roof is of wood.

Truck Shop.—This building is 82 x 434 ft. Three rows of wooden columns divide the eastern portion into four 20-ft. bays, and these support wooden roof girders, each 24-ft. centers. The west end has three bays and two lines of steel columns carrying the roof on steel I beams. The roof is lighted by 10 x 20-ft. monitors in each panel. The side windows are 8½ ft. wide x 12 ft. high, the space between them being 3 ft. The erecting track for trucks is provided with two pits 15 ins. deep and 18 ins. wide, outside of the rails, to facilitate putting the trucks together.

The Frog and Switch Shop.—This building is 102 x 264 ft. It is a special manufacturing plant for frogs, switches, switch stands, and kindred manufacturing. It has three bays, 52½-ft. main bays and an additional area of 148 ft., 27 ft. wide, for the cupolas, blowers, core and store rooms and offices. This part of the plant is shown with special pride, because it was planned with the sole object of efficiency, and without stinting the expenditure in any way. The floor area is well lighted by eight 9-ft. monitors, 53 ft. long. A 90-ft. length of the extension for the cupolas is carried to two stories in height to provide a charging floor. The annealing pits and storage space for wheels occupies a width of 40 ft. across one end of the building, this portion being served by a crane of 1½ tons capacity, running across the building. Hoists for handling wheels and flasks are arranged across the casting floor, and these deliver wheels to cars at the ends of the rows of moulds. This plant has a capacity of 300 wheels per day, and very large storage space outside of the building is provided for finished wheels.

The Freight Car Shop.—This building is a manufacturing

plant for freight cars; it is 107 ft. wide x 540 ft. long, with six tracks from end to end. For overhead lighting transverse monitors, 10 x 48 ft. in size, are located in each panel of 20 ft. The roof trusses are carried on steel columns, which also support runway girders for three 2,000 travelling air hoists in each bay.

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FREIGHT CAR SHOP, SHOWING CHARACTER OF CONSTRUCTION OF BUILDING AND ROOF.

FREIGHT AND PASSENGER LOCOMOTIVES.

NORTHERN PACIFIC RAILWAY.

2—8—2 MIKADO TYPE.

The Northern Pacific Railway has added to its heavy freight equipment 25 very heavy 2—8—2 type freight locomotives, 19 of which are simple piston valve engines with 24 x 30-in. cylinders, and 6 are tandem compounds, the general features being the same for both types. The simple engines are illustrated by the accompanying engravings. These locomotives weigh 259,000 lbs., with 196,000 on driving wheels, which is heavier than any previous design for the Northern Pacific. Readers will be interested in comparing these in the design with that of similar type built by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fe (AMERICAN ENGINEER, 1903, page 16). The weight of the Northern Pacific engines is not quite as great as that of the Santa Fe, and the heating surface is 4,000 ft. for the Northern Pacific as compared with 5,366 sq. ft. for the Santa Fe; the latter being next to the largest ever used on a locomotive. It is in the design of the boiler that the greatest interest in the new Northern Pacific locomotives centers, because this boiler marks a radical step toward increased facility of circulation of water at an expense of both grate area and heating surface.

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By comparing the new design with the heavy 2—8—0 types, put into service on this road since the year 1900, it will be observed that the boilers of the Mikado type have received a great deal of careful attention. The throat is 26 ins. deep, which is very unusual for a locomotive with a wide grate, and this constitutes a strong argument in favor of the 2—8—2 in preference to the 2—8—0 type.

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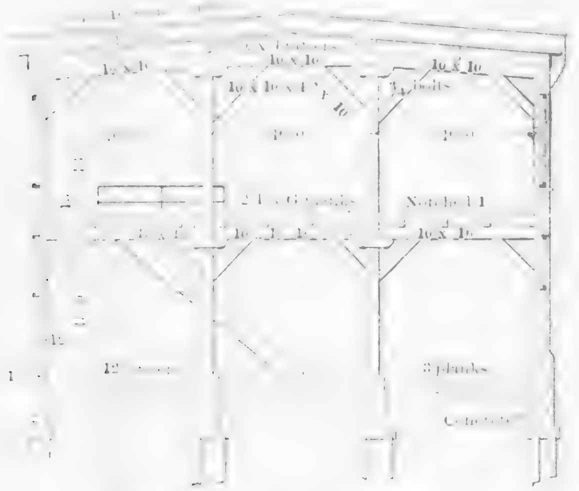
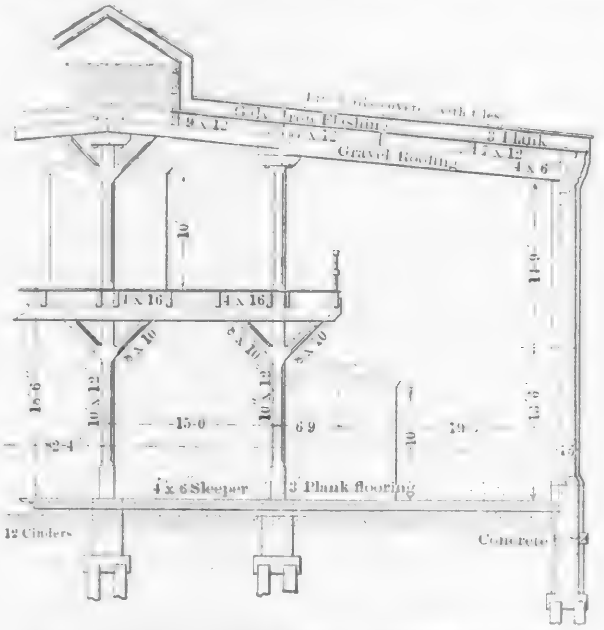


SECTION THROUGH PATTERN SHOP



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NORTHERN PACIFIC RAILWAY

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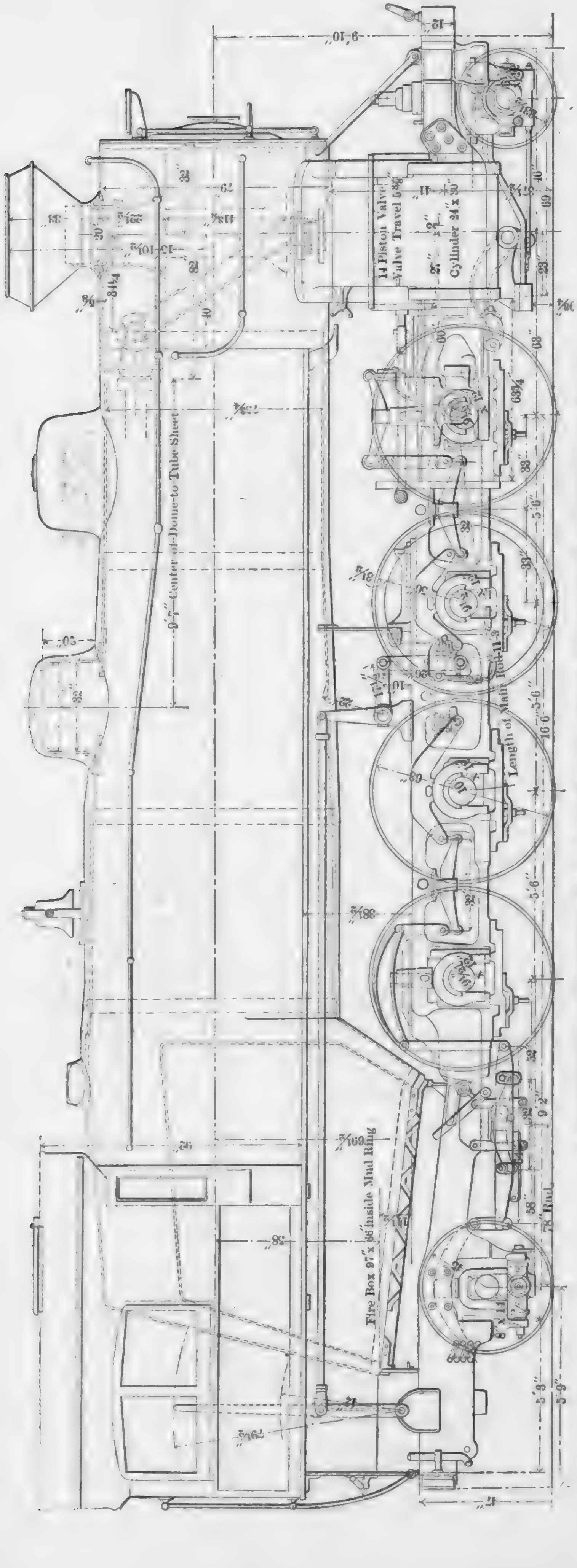
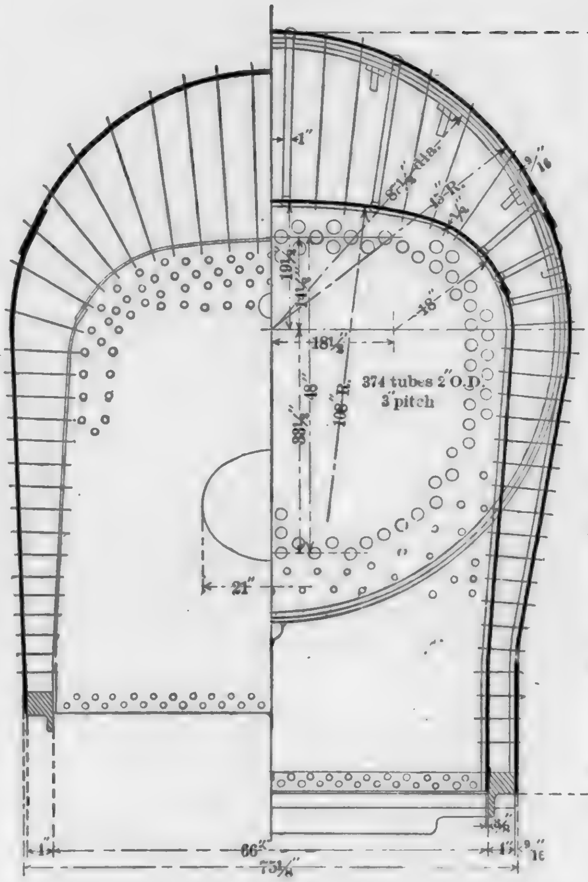


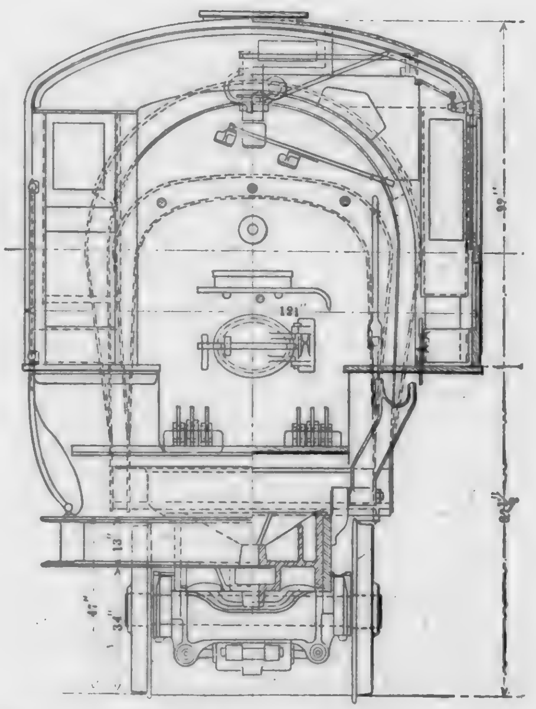
FREIGHT LOCOMOTIVE, 2—8—2 (MIKADO) TYPE—NORTHERN PACIFIC RAILROAD.

AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders.*

DAVID VAN ALSTYNE, *Superintendent of Motor Power.*

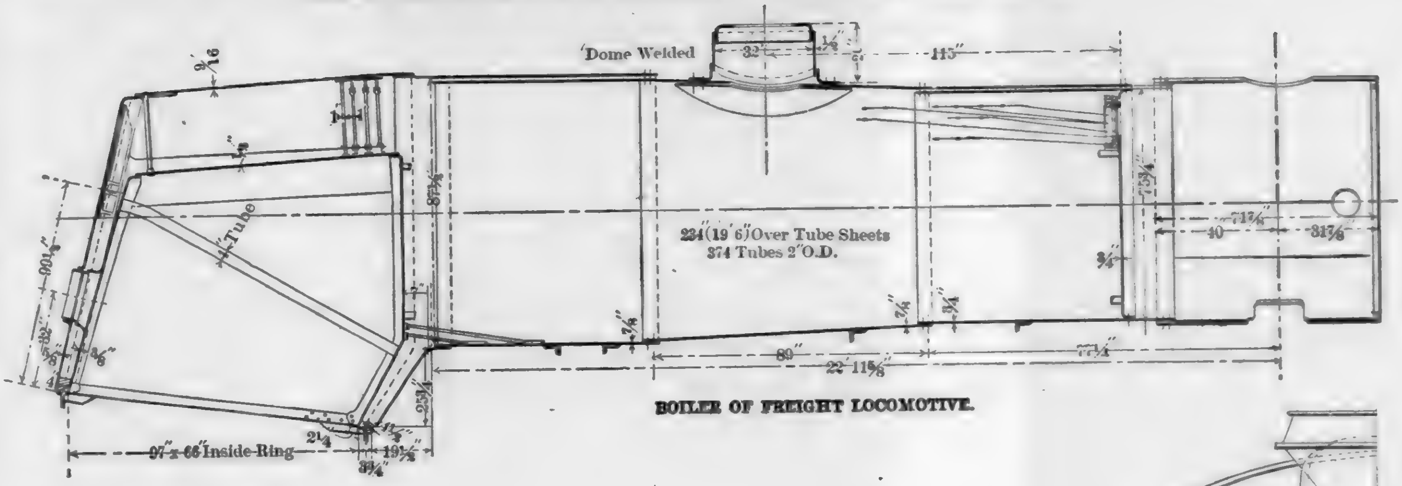


CROSS SECTION THROUGH BOILER FIREBOX.

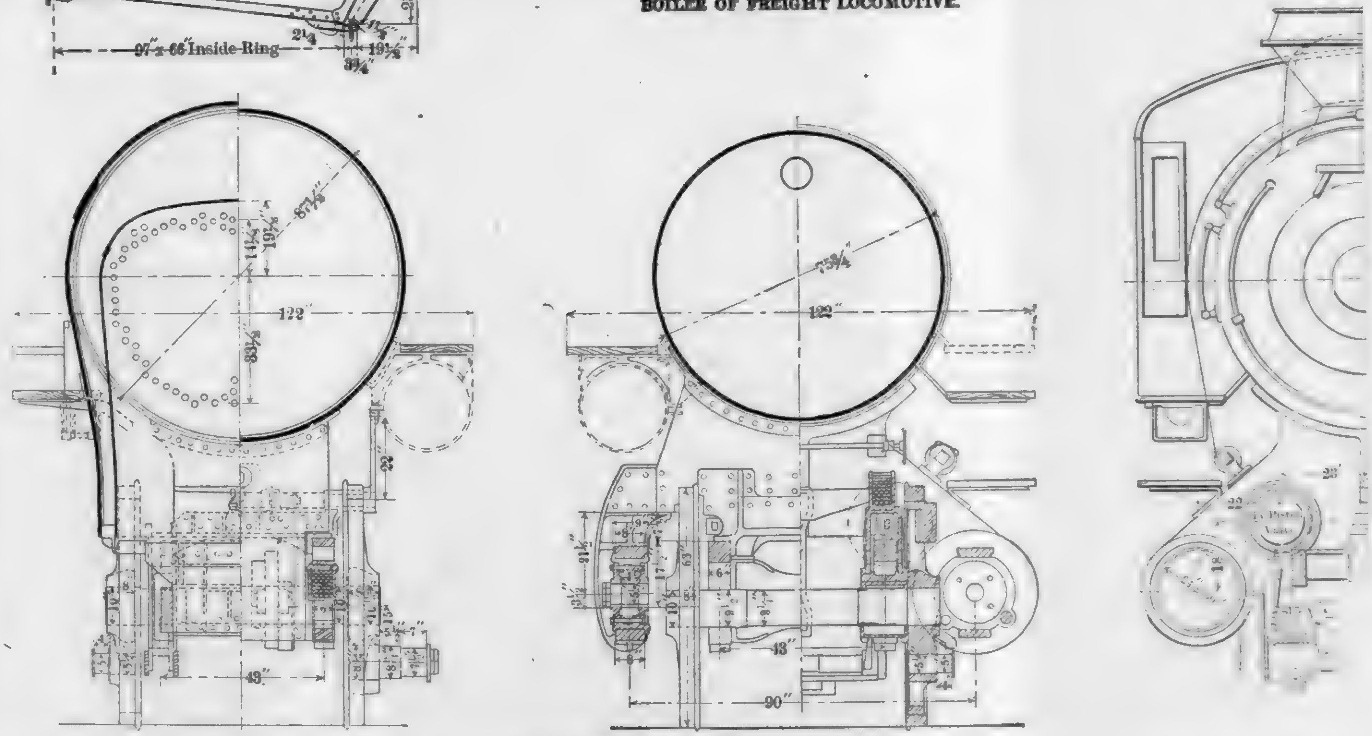


REAR ELEVATION AND CROSS-SECTION THROUGH CAB.

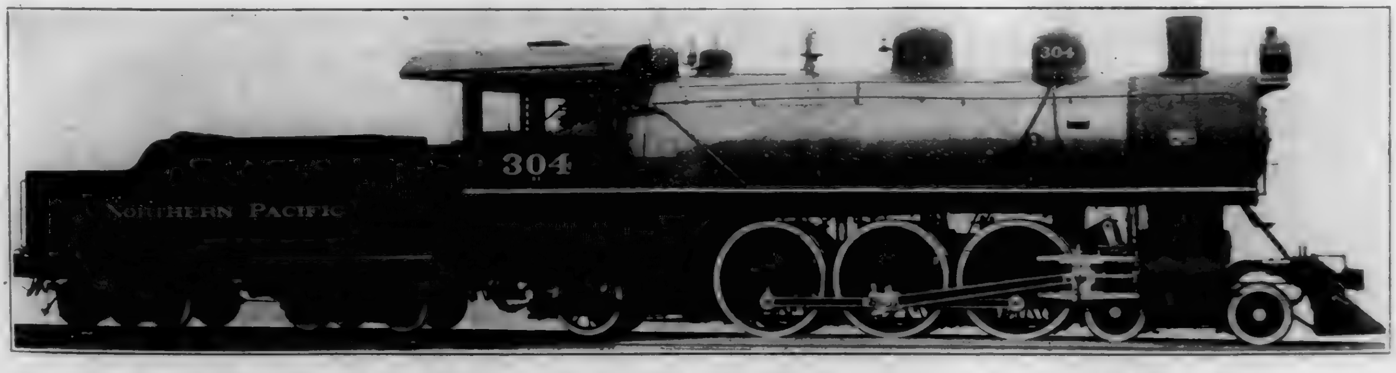
FREIGHT LOCOMOTIVE, 2—8—2 (MIKADO) TYPE—NORTHERN PACIFIC RAILROAD.



BOILER OF FREIGHT LOCOMOTIVE.



SECTION OF FREIGHT LOCOMOTIVE.



PASSENGER LOCOMOTIVE, 4—6—2 (PACIFIC) TYPE—NORTHERN PACIFIC RAILWAY.

DAVID VAN ALSTYNE, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

is 7 ins.; the water space at the sides of the firebox begins to widen at the fourth row of stay bolts, and furthermore the spacing of the 2-in. tubes is at 3-in. centers in both tube sheets. With this combination the boilers should not only carry their water well, but the circulation should be all that is desired, even in the bad water district between Mandan and Glendive, where these engines are to run. The grate area, 43.5 ft., is less than in recent boilers made as large as 75 ins. in diameter. All of these features are intended to enable the boiler to handle foaming water and improve the steaming qualities with the inferior grade of fuel which is available on the Yellowstone Division.

These engines are equipped with low nozzles and with diamond stacks in order to use Red Lodge coal, mined on the line of the Northern Pacific in Montana. This coal is very light and sparks very badly. For the reason that the Northern Pacific officials believe that it will prevent fires more effectively than the ordinary front end, the diamond stack was used. The stack base is extended into the smoke box and opens under a horizontal partition. The profile of the road between the points mentioned is that of a rolling country, with long stretches of 1 per cent. grade, with some of 1½ per cent. Thus far the engines have given good results, but they have not been in service long enough to justify positive statements as to performances. Mr. Van Alstyne, who has had considerable experience with tandem compounds, expects the 6 locomotives of this type to make a good showing in economy. These locomotives have tubes 19 ft. 6 ins. long and the driving wheels are placed very close together.

If the boiler of the new Northern Pacific design supplies steam adequately for these 24 x 30-in. cylinders, this locomotive is likely to influence future design in an important way. In our record of heavy locomotives there is only one other design having cylinders 24 ins. in diameter—that of the 2—8—0 type built by the Pittsburg Locomotive Works for the Bessemer & Lake Erie Railroad, illustrated in July, 1900, page 214. A number of 23-in. cylinders are running successfully on the 2—8—0 Rogers locomotive for the Illinois Central, illustrated in January, 1900, page 13; the 4—8—0 Brooks for the same road, illustrated in October, 1899, page 315; and the 2—8—0 Pittsburg locomotive for the Union Railway, described in November, 1898, page 365. The Northern Pacific engines are equipped with Player improved leading and trailing trucks and throughout the details indicate most careful design, with ample material so disposed as to reduce the liability of locomotive failures.

4—6—2 PACIFIC TYPE.

Simultaneously with the freight engines from the Brooks Works, 5 4—6—2 passenger engines were built at Schenectady and are illustrated from a photograph. This design follows the freight engines in the boiler features as to depth of throat, location of dome, large spaces between tubes (1-in. bridges at back ends and 29-32-in. bridges at the front end). The inside firebox sheets are vertical at the sides and the water spaces are the same as those of the freight engines. The passenger engines are similar in weight to the 4—6—2 type of the New York Central (AMERICAN ENGINEER, 1904, page 87).

Tables of dimensions of both freight and passenger engines are presented.

GENERAL DIMENSIONS OF NORTHERN PACIFIC LOCOMOTIVES.

	FREIGHT 2-8-2 TYPE	PASSENGER 4-6-2 TYPE
Cylinders	24x30 ins.	22x26 ins.
Track gauge	4 ft. 8½ ins.	4 ft. 8½ ins.
Tractive power	46,630 lbs.	31,000 lbs.
Wheel base, driving	16 ft. 6 ins.	12 ft. 0 ins.
Wheel base, rigid	16 ft. 6 ins.	12 ft. 0 ins.
Wheel base, total	34 ft. 9 ins.	33 ft. 0 ins.
Wheel base, total, eng. & tend.	63 ft. 1 in.	61 ft. 11 ins.
Weight, working order	259,000 lbs.	219,000 lbs.
Weight on drivers	196,000 lbs.	142,500 lbs.
Weight, working order, eng. & tend.	405,500 lbs.	347,000 lbs.
Heating surface, tubes	3,798 sq. ft.	3339.4 sq. ft.
Heating surface, firebox	200 sq. ft.	182.0 sq. ft.
Heating surface, arch tubes	9 sq. ft.	6.8 sq. ft.
Heating surface, total	4,007 sq. ft.	3528.2 sq. ft.
Grate area	43.5 sq. ft.	43.5 sq. ft.
Axles, driving journals, main	10x12 ins.	9½x12 ins.
Axles, others	9½x12 ins.	9x12 ins.
Axles, engine truck journals	6½x12 ins.	6x11 ins.
Axles, trailing truck journals	8x14 ins.	8x14 ins.
Axles, tender truck journals	5½x10 ins.	5½x10 ins.
Boiler	Extended wagon top	Extended wagon top
Boiler, outside diam., first ring	75¾ ins.	72⅛ ins.
Boiler, working pressure	200 lbs.	200 ins.
Fuel	Bituminous coal	Bituminous coal
Fire box	97x66 ins.	96x65¼ ins.
Tubes, number	374	347
Tubes, diameter	2 ins.	2 ins.
Tubes, length	19 ft. 6 ins.	18 ft. 6 ins.
Tubes, gauge	No. 11	No. 11
Engine truck	Radial	4 wheel swing
Trailing truck	Player radial	Radial, outside journals
Exhaust pipe	Single	Single
Piston, rod, diameter	4¼ ins.	4 ins.
Smoke stack	20x42 ins.	18x20 ins.
Smoke stack, top above rail	15 ft. 10⅛ ins.	15 ft. x 5½ ins.
Tender frame, channel	13 ins.	13 ins.
Tank	Water bottom	Water bottom
Tank, capacity	8,000 gals.	6,000 gals.
Tank, capacity fuel	12 tons	12 tons
Valves	Piston	Piston
Valves, travel	5⅜ ins.	6 ins.
Wheels, driv. diam. outside tire	63 ins.	69 ins.
Wheels, driv. centers, diam.	56 ins.	62 ins.
Wheels, engine truck, diameter	33½ ins.	33½ ins.
Wheels, engine truck, kind	Boise plate	Boise plate
Wheels, trailing truck, diameter	45 ins.	45 ins.
Wheels, tender truck, diameter	33 ins.	38½ ins.

REPORT OF COMMITTEE ON POWER.

CHICAGO, ROCK ISLAND & PACIFIC SYSTEM.

EDITOR'S NOTE.—Under the administration of Mr. L. F. Loree a committee was appointed to undertake a thorough study of the motive power of the lines comprising what are known as the Rock Island and 'Frisco Systems, and the report, recently completed, constitutes an exceedingly important and suggestive study of the motive power problem. The committee consisted of Mr. F. J. Cole, mechanical engineer of the American Locomotive Company, chairman; Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, and Mr. Robert Rennie, mechanical engineer of the 'Frisco System.

The subject is considered in seven divisions: (a) The condition of the present power and the order of its retirement, including the present value of power to be continued in service and that recommended for retirement. (b) The possible redistribution of the power to secure segregation of engines of similar character, to reduce the number of parts to be carried in stock and the cost of repairs. (c) Changes in design of existing power that will increase its capacity and usefulness and prolong its life. (d) The designing of five standard types of engines to answer the needs of the future, considering the present condition of grades and the conditions to be provided under prospective improvements. (e) A report on the economy and use of superheated steam for locomotives. (f) A report on self-contained motor cars for branch lines. (g) A report on balanced locomotives.

VALUATION OF POWER.

This general question is very complex, requiring the consideration of many conditions and factors. In general, the cost of repairs and maintenance increases with the age, and it is reasonable to expect that the cost per mile run will be very much increased when the life of the engines is prolonged beyond natural limits. If no further improvement of design was possible, and the weight was suitable for economical service, it could be conceived possible to indefinitely prolong the life of a locomotive. As each part wore out, a new one could be applied, and the locomotive would therefore be renewed piecemeal. This process would continue until nothing remained of the original construction. Of course, this condition does not exist at present, and such a method would be extremely uneconomical. It is frequently desirable to scrap small locomotives, because of being too light for economical service. This may result from improvements in bridges, or increase of traffic, which would render it desirable to dispose of light engines before they had reached their limit of age or usefulness.

Another condition to be considered is that the demand for light power is such at the present time (and likely to con-

tinue for several years), that if the retirement is carried out on a basis of age there may be a considerable shortage of power. It would appear extremely undesirable to purchase additional light power, and every endeavor should therefore be made to prolong the life of this power, and shift around lighter engines from other parts of the road, in order to fill the demand, and to generally resort to every expedient to avoid purchasing new light engines. Additions to power should be made of the heavier classes. It would seem permissible where the machinery is sufficiently heavy, and its condition generally good, to maintain these light engines, which are absolutely essential for economical performance, by renewing some of the boilers and fireboxes up to the limits of some predetermined expenditure, based upon a percentage of the original cost.

On the other hand, it is well known that repairing and rebuilding of power, which is by no means up to modern requirements, is on some railroads carried far beyond the limits of economy. Instances of this may be cited on other roads, where the cost of such work amounts to from 50 to 60 per cent. of the original cost, and is out of all proportion to the benefit derived. Boilers with greater heating surface and higher steam pressure are often applied to engines with light machinery, thus overloading bearings and over-straining the working parts. This invariably results, sooner or later, in a large increase in engine failures, due to the breakage of parts, and while the efficiency of the engine may be temporarily improved, the cost of repairs per running mile is very much increased.

Recommendations for the valuation and scrapping of equipment are based generally on a life of 20 years, and 5 per cent. annual depreciation from the original value (less the scrap value) for all serviceable heavy power. Generally speaking, engines of 20 years of age and over are recommended for scrapping when they require repairs costing over a certain percentage of the original value, as referred to later on. If the boiler has been renewed, the date of renewal should be ascertained, as a new boiler would probably prolong the usefulness of the engine for a period not exceeding fifteen years; but in no case do we recommend that the life of an engine be considered as over 30 years. Before a new firebox is applied to an engine 17 or 18 years of age, the boiler of which has not been renewed, a careful examination should be made of the boiler, and its general conditions regarding corrosion, cracks, patches, etc., ascertained, to see if the expenditure is justified, as the renewal of boilers on engines of this age is not recommended as a regular thing. Because of the present demand for certain classes of light power, the expenditure for boiler renewals may be justified on account of heavy machinery and good condition of frames, cylinders and running gear.

Depreciation is based on the value when new, taken at the actual cost of the engine. When this cannot be obtained it should be estimated or assumed at a certain arbitrary price per pound, according to the weight and type, the value in the latter case to be based on the weight in working order. The water in the boiler and the weight of the fire will approximately offset the scrap value of the tender. The value of scrap is estimated at an average price per pound which would be realized if the material is used or sold, this price to include the cost of cutting up. The present value of engines recommended for scrapping is taken at ¾ cent per pound of the engine only in working order.

(The method used by the committee in estimating the value of a locomotive at any age from one to twenty years, together with tables and diagrams for estimating the depreciation, will be presented next month.)

(*To be continued.*)

ORGANIZATION AND OPERATION OF A RAILROAD BLACKSMITH SHOP.

By A. W. McCaslin.

The well-organized railroad blacksmith shop of to-day will, in many respects, show quite a departure from the railway smith shop of a few years ago. The foreman capable of organizing this shop and satisfactorily meeting the demands at the present time, will be a good mechanic, with a thorough knowledge as to what will constitute a perfectly organized system in his particular shop. He will be acquainted with the merits of the most perfect forge, as well as the demands for and the possibilities as to output of furnaces, steam hammers, shaping machines, etc. He should have some inventive ability, that he may devise the necessary tools for the hammers and machines, which have nothing to their credit but latent power. Should he be incapable of designing or making the many tools suggested by the many different articles he is daily called upon to produce in large numbers, this power will be valueless and will occupy shop space needed for the extra number of men required to meet the demands made upon his department. This inability, or as we sometimes think, indifference, is frequently and justly the cause of his being superseded by some one who is capable of making the necessary tools to increase the output in keeping with the times. We find this qualification more essential in the foreman smith than in the foreman of any other department.

When machines are purchased for the other departments, they are generally accompanied with tools for many purposes. But it appears if the foreman smith is furnished with striking and pushing power, it is about all he is entitled to, and the utilization of this power to advantage and profit to his company and credit to himself and men frequently causes a lone seance in his endeavor to materialize imaginary movements. Should the foreman be capable, yet without privilege, or expected to draw his ideas, designs and blue prints of the necessary tools to expedite the work, from the office of those higher in authority than himself—which we believe is a pet rule on some railroads at this time—the output will suffer equally, if not worse, and the cost of production be greater than with the incompetent foreman with full privilege to do his best. We should never hesitate to spend one dollar of the company's money on tools if we can guarantee one hundred dollars in return. If the tool be a proper one for the purpose intended, this seemingly high percentage in favor of the tool or machine output against the production by hand will invariably be realized. The shop should have a sufficiency of the power and furnaces referred to, and a blast pressure of 14 to 15 ozs. per sq. in. The advantage of this pressure is a greatly increased output against that produced with a pressure of 6 or 7 ozs. as used in some shops, which, with their consequent output of only about 50 per cent. of what it should be, grants the workmen a legitimate excuse for it.

The foreman should consider well his appointments of men best qualified to produce the work assigned them. For instance, the man operating the large fire should be a first-class mechanic, who understands perfect heating and the making of heavy forgings. The men on the lighter fires, as well as those working on machines, should be placed and rated on down to the apprentice boy, according to their ability, aptness, etc. The tool dresser should be a wideawake, thinking man, with experience in the treatment of steel, interested in his work, and he should not be urged faster than the best treatment of the steel will permit. While he may forge and dress the high speed tools, he has not sufficient time to properly harden and keep the run of this grade of steel. This, in connection with the hardening and tempering of all taps, reamers, milling tools, etc., is the special duty of another.

When the shop is perfectly organized on conditions equally favorable to the employer and employe, the following are the paramount requisites in its operation: System, discipline, a consideration and fair treatment given the men recognized by them to be just, and a satisfactory proof to them that the foreman is familiar with what constitutes one hour's work, or a full day's work, in any and all work given them to do. This fact established and well understood by the men, and kept alive by the foreman in his prompt distribution of the work needed to fill orders against his shop, will minimize the difficulty experienced by some foremen in obtaining a fair output

per man. In connection with this qualification, the foreman should set a fair price for the making of each item. The list of prices should be placed in the shop where the men can refer to it, and the prices should be established according to the facilities at hand for doing the work. Under the day-work system a schedule of prices is necessary, that we may be able to operate intelligently. We are daily called upon to give the cost of producing this or that item, and to make estimates on work in contemplation. It is a specific for the disease of the chronic "time killer," and greatly relieves the over-anxious one of worry by knowing he has done all or more than was expected of him. In a manner, it makes each man his own foreman, and also relieves the one who has full charge and is held responsible for the output of the shop of the unpleasant duty of urging them to a fair day's work.

The writer established the schedule rule some years ago the shop he has charge of, and it has proved perfectly satisfactory to the men, giving them, as it does, steady employment, and to the company by an increased output up to the full limit of good workmanship. But we should not forget that we are living in an advanced age, an age of quick production and keen competition, the stimulus of which has revolutionized the crude and slow method of production by hand in the smith shop of a few years ago to the rapid output of to-day by machines and their complement of proper tools.

We will follow this change of method of production by illustrating with only a few of the minor articles in constant demand. Yet a like change giving an increased output has taken place in a greater percentage of the full output of the shop. A few years ago drawhead pockets were made under the steam hammer at about one-quarter of a cent per pound. To-day they are made by the geared or pneumatic bulldozer at about one-eighth of a cent per pound. They were applied to the drawheads by hand at a cost of about 10 cents each. To-day they are applied by the small pneumatic bulldozer for about 2 cents each. Grab irons were made by hand on the anvil for 10 cents each. The steam hammer with the proper tools cut this price in two. The geared machine in its turn reduced the price set by the steam hammer, and to-day they are made on both the quick-action header or the pneumatic machine with specially designed tools for about 1 cent each, *day work*. Arch bars formerly bent by 3 or 4 helpers sledging them to the shape of a former, are now made on the 100-ton bulldozer or pneumatic machine for about 3 cents per 100 lbs. The cost of this class of machine work depends largely on the capacity of furnaces.

Many heavy parts of coaches, such as transoms and equalizers, are now bent on the bulldozer more accurately, at less cost, and with less abuse to the material than they formerly were under the steam hammers. This change of method for the better follows on through many of the heavy parts for engines. Main and side rod straps were pretty generally, and are yet by some, forged and bent in a solid or rigid tool under the hammer, thus upsetting, disarranging and frequently breaking or checking the fibre on the under side of the bend (in the corner), which is the vital part of the strap, as they never break on the outside corner first. They are now forged under a hammer of the proper weight and bent with rollers on the bulldozer. The forging is left full where the bends are to be made, and with the rollers properly adjusted the outside of the metal at the bend is elongated sufficiently in the rolling process to accommodate the inside to a natural easy bend. Placed on a mandril and given a few blows under the hammer, it is without strain or distortion of any kind.

To emphasize the great advantage realized in the reduction of cost of output with proper tools, against hand work, I will make two more comparisons in minor articles. Some years ago drag chain hooks were made by hand of 1¾-in. stock at a labor cost of about 25 cents each. To-day they are forged of 2-in. square soft steel and bent on the small pneumatic machine at a total labor cost of 5 cents each.

Chipping hammers, such as used by machinists, boiler-makers and car-repair men, were made by hand at a cost of 30 cents each. They are now forged in tools under the steam hammer for 12 to 15 cents each.

I will at this point give a list of only a few of the many items that can be made with small power. One 12-in. cylinder, or 2 9-in. cylinders placed tandem on a small face plate for bulldozing purposes, will, with 100 lbs. of steam or compressed air, have sufficient power to bend the following articles: Drag chain hooks forged of 2-in. square soft steel; drawhead carriers, brake hangers, unlocking bars, lever guides, stake pockets, train pipe clamps, step irons, corner bands, end gate irons and grab irons as fast as they can be handled. By using 1 16-in. cylinder as described above, drawhead pockets can be applied for 2 cents each. Such cylinders can be found in most railroad shop scrap boxes, and if the foreman is denied something better they should be utilized as labor-saving devices.

The best workmanship and greatest output is obtained in the general run of the work by classifying it and giving each man all or as much of his particular class of work as he can do. In this way men become expert. Their work will be less laborious to them, the output will be increased and the quality will be of the best. If the foreman is a practical blacksmith, thoughtful and persistent in applying himself to duties as he understands them, there should be but little if any cause for complaint from his superiors.

The advantages derived from railway club and association meetings, which make not only common property of the over-estimated private shop kinks, secrets and formulas of the past, but offer to those who can appreciate the best and latest ideas and methods of to-day, and added to this the knowledge gained by being a reader of the railway mechanical publications, which give in almost every issue cuts of the latest machines and tools with their capacity, should help him to not only satisfy others, but, better still, to satisfy himself.

BOSTON & ALBANY RAILROAD PROGRESSIVE ASSOCIATION.

To the Editor:

It may be of interest to you to know that for some time past on the Boston & Albany Railroad, there was under consideration the advisability of starting an organization, practically a school for instruction on the locomotive, signals, train rules, etc., similar to that outlined in the editorial entitled "Education for Shop Men and Engineers" in your November issue.

This finally resulted, through the efforts of Traveling Engineer E. H. Smith, in the organization of the Boston & Albany Railroad Progressive Association, on November 22, with 18 charter members and more added each meeting since. The association is limited to employees of the motive power department, and will not admit officials. Two meetings a month are held and instruction is given by illustrated lectures, using a stereopticon, models, drawings, etc.

When the association was brought to the attention of the railroad officials they willingly fitted up a room at Allston with a seating capacity of about 60, gave the members permission to use books and drawings, and in every way offered encouragement and help. Firms manufacturing railway appliances were asked to aid and they promptly furnished drawings and in several cases full size models. All the argument needed, as one firm put it, was "the more your men know about our device the better satisfaction they will get from it."

The course of lectures planned for this winter will cover the locomotive; the first lecture is boiler construction, design and care. By using illustrations, models, etc., intelligently explained and freely discussed, the progressive examinations will lose much of their dread.

The Boston & Albany Railroad Progressive Association has had a fair start, with the good wishes of all, and we feel confident that after the meetings this winter the members will find that the modern locomotive is much less a mystery than heretofore.

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ECONOMICAL TRAIN OPERATION.

By G. R. Henderson.

PART IV.

DEDUCTIONS AND CONCLUSIONS.

In making a study of train operation (such as we have just done) it is important that the different features be brought out clearly, so that their full value will be understood. The results are what is wanted in railroad operation, more than departmental benefits. The president of one of the most important lines in the Northwest once stated the matter clearly when he said: "If one deparment can so spend a dollar that another department can save a dollar and one cent, the expenditure must be made, regardless of the fact that the spending department was increasing its expenses." This is too often overlooked in departmental jealousies, and we frequently hear remarks such as "My department will not get the benefit of such an expense or improvement, and I am not going to increase my rolls." Then again, it is not an uncommon practice, when an excess of power has to be moved in a certain direction, for a division superintendent to send out one engine light, and one a few minutes after with a load that it can barely draw up the hills, simply to increase the average tonnage showing per single engine train mileage or per train mile, a light engine not being considered a train. If we use more fuel per 100 ton miles, but the saving in wages of crews more than offsets the value of this excess, the company is ahead, even if the general manager asks the motive power department disagreeable questions—questions which may be hard to answer unless the head of the department is well fortified both with theoretical knowledge and the practical results obtained. Unfortunately, while the motive power department may fix the rating of the engines, the general or division superintendent fixes the running schedule, and this is done independently of the former, and often without any knowledge of the effects of speed upon the coal consumption or the total cost of transportation. This is unfortunate for the railroads, but it is the usual method in this country.

In analyzing Table A it is noticed at once that the supplies (excepting coal) and the roundhouse charges are independent of changes in speed or the rating of the engine. In order to make these items a minimum per ton mile covered, we should use as heavy a train as possible; but these items are small when compared with the others, so that they really but slightly affect the general result. The repairs being based on ton miles, will not affect the cost per ton mile by changes in the speed or loading, under our hypothesis. The interest charges are small, so that even if it be claimed that the engines are in the house and interest must be paid whether used or not, the result will be but slightly affected. This leaves us only the fuel and wages, which are large items in point of cost, and which depend upon the speed and load.

Fig. 3 is introduced to show graphically the results caused by varying the load, and consequently, the speed. The lower diagram is arranged to show the effect of changing the load back of the tender. Examining the line marked "average speed, No. 6" (the numbers referring to the line in the table corresponding to the same item), we find that a decrease in load of 30 tons (say one car), or from 1,450 to 1,420 tons, permits doubling the speed, while to treble it, 260 tons must be dropped, and to quintuple it, more than half of the full load must be left over for another train. The greatest benefit of a decreased load is therefore found at slow speeds, where a reduction of 2 per cent. enables the engine to run at double speed. We observe from line No. 21 that the coal consumption per ton mile has risen 17 per cent., and if this were a general thing for the month, the superintendent of motive power would have to answer questions, which, it is possible, he could not do unless well acquainted with the train movement for the month. But let us see what has been gained.

The total cost of movement per 1,000 ton miles moved has been reduced 5 per cent., and the same engine or engines have increased the ton mileage over the division 75 per cent.! Here is where the division superintendent gets the credit for the large amount of traffic handled, and the motive power department gets a "raking" for the increase in coal consumption.

"These things ought not so to be." But if a little reduction in the load is good, will not more be better? And where should we stop? Unless we are considering a stock movement or a lot of perishable freight, we can find the answer in Fig. 3 and Table A. It happens in this case that a load of 1,190 or say, 1,200 tons nett, gives us not only the lowest cost per 1,000 ton miles, but also the maximum monthly movement. The engine is able to run at 15 miles an hour, or with 20 per cent. in stops, etc., to average 12½ miles an hour; this brings about a reduction of 16 per cent. in the operating charges scheduled, and an increase of 98 per cent. of stuff hauled; in fact, while the train load has been reduced 18 per cent., the engine has made the trip in one-third of the time,

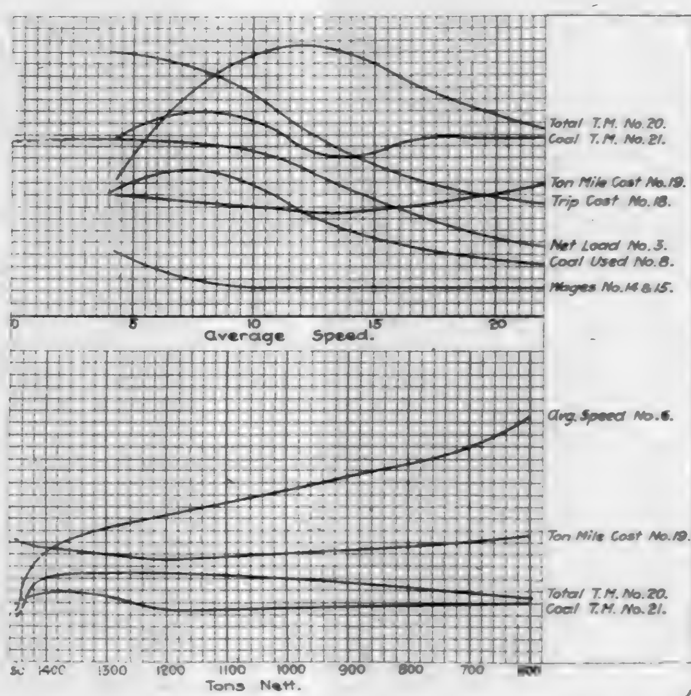

FIG. 3—EFFECT OF VARYING THE LOAD AND SPEED.

and has done the work of two locomotives! If we compare the two methods of operating, we see that a division worked in accordance with the first schedule would show better records for large train loads, and if the general manager had a hobby for heavy trains, the superintendent would get more praise than in the third case, where he got twice as much work done per engine at 5-6 the cost of movement.

From the replies to the inquiries mentioned in Part I. it was clear that the benefit of reducing loads in times of traffic congestion was generally conceded, but the above discussion suggests that it would be good practice at all times, on such a division and under the conditions which we have assumed. It demonstrates that heavy trains do not always mean economy—not even in coal consumption, as it is seen that the rate per 100 ton miles is less at 15 than at 5 or 10 miles an hour.

As we still further reduce our load, and operate at higher speeds, we lose both in economy and in total work done; the rate of fuel consumption also increases. These circumstances are brought about by the fact that it takes more coal per ton mile to move a train fast than slow, and that after we average 10 miles an hour there is no reduction, caused by the speed, in the wages of the crews, they being paid by the mile, as already explained.

The upper diagram of Fig. 3 illustrates the variations due

to speed. Here it will be seen that the line of wages is horizontal above 10 miles an hour. From lines 18 and 19 it will be evident that while the cost per trip decreases with each increase of speed, the cost per ton mile decreases to 12½ miles an hour average speed, and then increases for further increase in velocity. The same is approximately true of the coal consumed per trip and per ton mile. Under the conditions assumed, therefore, it appears that economical operation, both from a standpoint of large movement and low unit cost, demands loading the engines so that they can make 15 miles an hour while running. Of course, it is supposed that there are sufficient sidings, etc., to allow a prompt train movement in both directions.

Case A, which has just been considered, may be claimed to be a purely hypothetical one, and not occurring in ordinary practice. We admit that divisions 150 miles long, with a continual rise of 1 per cent., are not common, and yet the writer knows of even worse cases. But B and C are very ordinary cases, the one having a summit at the middle of the run, and the other constituting a rolling profile. Under these suppositions, it will not be necessary to consider the direction of prevailing traffic, as the operations in either direction will be identical. In comparing tables A and B we are at once struck with the difference in cost of operation, the latter being about 2-3 of the former. Inspection shows us that this is due chiefly to the quantity of coal burned, which is only one-half that used for the continual rise of case A. Under the same hypothesis, the return run of case A would be made without burning any coal, and the round trip would in a measure approximate to case B, except that a very large tonnage could be brought down hill, if it were there to be handled.

As before, items 10, 11 and 16 are unchanged throughout the variation in schedules, and with numbers 12 and 13 are the same as in case A. The down grade speed being maintained at 25 miles an hour, the average speed over the division is greater for the different speeds up hill than in the previous case until it reaches that due to 25 miles an hour on both sides of the hill. The wages (14 and 15) being identical per trip for all but the first schedule, increase the cost per ton mile at higher speeds and reduced loads.

Considering the questions of cost of operation and work accomplished, we are struck in our examination of table B with the fact that the cost of handling per ton mile is the same, whether a speed of 5 or 10 miles an hour up hill be permitted. It happens in this case that the increased fuel consumption due to greater speed is fully offset by the reduction in overtime, due to such speed, as the trip only occupies 12.6 hours between terminals instead of 21.6 hours. The amount of traffic handled per engine each month has, however, been increased 48 per cent. Under these two operating conditions, the expense is just the same, and the first method will enable the superintendent to show heavier train loads, where this is considered most creditable, but the second arrangement permits a great increase in traffic handled, besides keeping the men in much better humor on account of a quick run over the division, which is not without a good effect upon the morale of the service. However, if we go still further and cut our train load 18 per cent. so that 15 miles an hour may be made up grade, a reduction in the cost of operation of 6 per cent. is effected, with 50 per cent. increase in work done per engine, or two locomotives run on this schedule would do the same amount of work in cleaning up a congested freight yard as three on the first schedule. It also happens in this case that the coal consumption per 100 ton miles is less, due to expansive working of the steam in the cylinders.

If the load and running time be still further reduced, the economy and amount of business handled will suffer—thus at 25 miles an hour the cost per 1,000 ton miles will be 32 per cent. greater and the tonnage handled per month 40 per cent. less than at 15 miles per hour running time. This shows us why stock trains are so much more expensive to handle than ordinary freight, the increased cost being as above for similar existing conditions. If the speed be still further increased, the excess in cost will be yet greater, and the amount of tonnage smaller. These figures give a logical argument for higher charges for such freight, in addition to terminal expenses for handling and caring for the stock while in transit. Of course, everyone knows that freight rates are not determined by the cost of transportation, and yet it is desirable to know the relative cost of different kinds of service. As before, 15 miles an hour running time gives the greatest benefit, both as to economy and amount of business handled.

In case B, just considered, the average profile was level, that is, there was as much down hill as up hill, and the schedules were determined by fixing the working speed up grade. In case C, while the profile is still level, as far as the average is concerned, the up grades are so short that it would never be considered good policy to load an engine so that it could make fast runs up these hills, but the level stretches must be depended upon to make up time on a fast schedule. For this reason but two ratings are used in our discussion, 1,870 tons and 1,820 tons, or 3 per cent. less. From Fig. 2 this was seen to make a difference of from 5 miles to 10 miles an hour on the 26 ft. per mile up grade, but as the up grade only comprises 30 miles of the 150, this really increased the average speed but 23 per cent. for the whole run. Again, however, there was an advantage in operating, as the total monthly ton mileage was increased 15 per cent. without any increase in the cost of operation, both standing at 45 cents per 1,000 ton miles. The coal consumption, however, is 13 per cent. greater, so that the only gain is in the increased hauling capacity of this schedule. If we consider trip 3 we find that the time between terminals is the same as trip 2, viz., 15.8 hours. In this case, however, the time is 5 miles an hour up hill and 15 miles per hour on the level. With this arrangement the full tonnage can be taken, resulting in an increase of about 3 per cent., and the cost is about 2 per cent. lower. In this case we find the greatest economy is to use the full rating and to run at 15 miles an hour on the level. While there is very little difference in the ton mile cost of the various schedules of case C, yet this method gives the lowest cost of operation both per train mile and ton mile of the series.

Now let us examine a still further increase of speed on the level, say to 25 miles an hour, but maintaining our full load and slow speed up hill. Here we find (trip 4) that the cost of operation has suffered a rise of 5 per cent., but the rate of output has improved about 16 per cent. This output can be still further increased by reducing the train load so that 10 miles an hour can be made up hill, the level speed being continued at 25 miles an hour, as exhibited in trip 5. Here the monthly rate is 41 per cent. better and the cost per ton mile only 8 per cent. more than trip 3, which was the lowest in cost. This table (C) therefore, indicates that for ordinary working conditions, the method shown by trip 3 is the most desirable, as it is the lowest in cost, but if traffic should become congested, great relief (that is 41 per cent.) can be effected by using schedule 5, thereby increasing the cost 8 per cent.

Although tables B and C cover operations over divisions that are an average level, we find great differences in the cost and best methods of operation. The most economical operation of case B (1 per cent. grades) cannot be expected to approach within 40 per cent. of the economical working of case C (½ per cent. grades and level stretches). This is due entirely to the profile of the road, and explains the uselessness of attempting to make comparisons of the cost of operation of different divisions, which have unlike profiles. Even the same profile with a different kind of traffic will be subject to great variations in cost. For instance, if one month there were few fast freights, and the same month in the following year there was a large proportion of this business, the expense of operation would be sure to go up unless there were other offsetting conditions. In this way praise or censure is often given when no one is responsible for the changed conditions, unless it be the traffic department for obtaining a different grade of merchandise for shipment. It is absolutely impossible to make comparisons in such cases unless all the conditions bearing

on the case are known or considered, yet it is often done in just such an unmethodical manner. Comparative statements, apparently voluminous and complete, often omit the essential points for forming sound judgment.

In one point the 3 cases considered practically agree, that at an average speed of from 12 to 15 miles an hour the greatest economy is found, but the possibility of moving a large quantity of freight depends upon the detail conditions of the line. Whether a heavy or moderate loading for the engine is best depends also upon the profile and existing conditions. It must not be thought that the 3 sections of road here considered are intended to cover all cases—indeed, each division should constitute a study by itself in some such manner as we have indicated, and the necessity for liberal co-operation between the various departments will certainly be understood by the foregoing suggestions. In each case the proper values should, of course, be assigned to the different items constituting the charges, as these will be different for various localities.

As we explained in Part I., the whole cost of operation will be about 3 times that shown by our figures, which include only the items directly connected with the train movement, and without knowing the amounts of these other charges the total cannot of course be figured, but for determining the minimum cost and maximum capacity, it is not necessary to know the items not directly concerned. The total cost of operation will evidently not be a function of the cost shown, but an addition to it, which is less per ton mile as the quantity of commodities handled increases.

The revenue ton mile is also much less than the gross ton mileage (car and loading) which we have considered above. In a fully loaded car the revenue load may be 2-3 of the gross load, but the ordinary run of loads as they come in merchandise trains will not average over 50 per cent. of the total weight for the weight of revenue freight. It is quite plain from the discussion that roads with heavy grades are unable to operate at the same cost as those with low grades, and that where we find a low operating cost for a large system it means that the great proportion of easy profiles modifies the high cost of mountainous territory, reducing the average. Where two railways connect at the same points, but one runs over a succession of mountain ranges, it is a hopeless task to expect to reduce the expenses to that of a road which has a valley route, unless it be badly managed. However, much can be done by adopting *an economical train load*, whether it be the greatest that the engine can haul or a moderately heavy load permitting a good running schedule, this to be determined for each particular case on the principles laid down above.

AUTOMATIC STOKERS FOR LOCOMOTIVES.—The necessity for an automatic stoker for the large locomotive, either passenger or freight, is quite generally recognized, and the requirements have been met in a very satisfactory manner by at least one form of stoker. It is strange, therefore, that a stoker which has been upon the market for several years, and which works so successfully, does not become regularly adopted by the railroads, which seem to need some such appliance to assist the fireman in his arduous work. The testimony as to the success of this device is the most convincing of any relating to locomotive improvements (containing such radical changes in methods of operation) which have been introduced in many years. The reports of the laboratory tests at Purdue show it to have given a very satisfactory performance. The testimony of motive power men who have had quite a number of stokers in use is entirely favorable to the device, and the opinion of the superintendent of our largest locomotive works is that the stoker is the coming device.—*Wm. Forsyth, before International Engineering Congress.*

The American Locomotive Company has presented to Purdue University, Lafayette, Indiana, the full-sized model locomotive cylinders sectioned to show the piston valve construction which formed a part of its exhibit at the Louisiana Purchase Exposition.

THE COLE 4-CYLINDER BALANCED COMPOUND.

An important, but misleading, criticism of the Cole 4-cylinder balanced compound locomotive appeared in a recent number of the *Railroad Gazette*, over the signature of Mr. L. E. Moore, instructor in mechanics, of the University of Illinois. This criticism cannot have been based upon mature deliberation, and to guard against the possibility of creating a widespread impression to the effect that this locomotive is not vertically balanced, a statement of the facts seems to be required. Mr. Moore's criticism is as follows:

"As regards forces in a horizontal plane through both axles, the locomotive is balanced; but consider for a moment the vertical forces upon the back pair of drivers alone, when rolling on the track. The conditions here are exactly the same as in an ordinary locomotive; for the vertical forces exerted by the reciprocating parts connected to the front drivers cannot interpose between the back drivers and the rail to balance the vertical forces exerted upon the back drivers by the reciprocating parts connected therewith. It must follow, then, that the reciprocating parts connected to the back drivers, being unbalanced, and quartering or at 90 deg. with each other, must produce a very severe hammer-blow upon the rails at every revolution. The same reasoning, of course, holds with the front drivers. If all these cranks were on one axle, or if the two cranks on each axle could be opposite, and similar parts had the same weight, the engine would, of necessity, be exactly balanced. But the splitting up of the cranks, as done in this engine, between the front and rear drivers, must necessarily result in unbalancing the vertical forces upon each axle. These forces are the ones of importance, so far as destructive action upon the rails is concerned."

The arrangement of this locomotive was illustrated on page 240 of the June number of this journal of last year. Mr. Moore has fallen into the error of regarding the reciprocating parts as producing a "hammer-blow" upon the rails at every revolution. In a balanced engine one set of reciprocating parts on the inside of the frames balances those on the outside, which move in an opposite direction, so that the use of the customary counterweights for the reciprocating parts in the wheels are rendered unnecessary, and engines of this description run very smoothly without their use. This is clear to anyone who reads what is said of the smooth operation of the many de Glehn compounds in Europe.

The action of the reciprocating parts is entirely horizontal, and no vertical force can be exerted by these parts, excepting the slight vertical component produced by the main rod, hence no pressure can be produced upon the rail by the action of the reciprocating parts. Mr. Moore confuses this with the "hammer-blow" in ordinary engines, which is produced by the overbalance in the wheels of ordinary engines to take care of the reciprocating weights, but even in these engines the reciprocating parts themselves have nothing directly to do with the "hammer-blow." With a 4-cylinder engine of this construction it does not matter whether the cylinders are all connected to one axle or not, as far as the balancing is concerned. In either case the reciprocating weights counteract each other, and the balancing of the rotating parts is all that is necessary; as a matter of fact, a very large proportion of 4-cylinder compounds of this general type are divided, as are the DeGlehn compound, the Cole compound and the Burlington compound, all of which have been illustrated in this journal. The Cole locomotive referred to has been run continuously for an hour on the Pennsylvania testing plant at St. Louis at a speed of 75 miles per hour, which alone effectually refutes Mr. Moore's criticism in the smoothness of the running, and in the demonstration by means of wires run under the wheels, these wires having been flattened uniformly throughout their entire length. Mr. Moore's criticism would be important if true, but those who are interested in the 4-cylinder balanced compound are very glad that his criticisms are erroneous.

MILLING MACHINES IN RAILROAD SHOPS.

The comment on the extensive use of milling machines in English railroad shops, which appeared on page 344 of our September issue, suggests the question as to why the same does not hold true in American shops. With the rapid progress that has been made during the past few years in the way of new shops and new equipments of modern tools fitted with the best cutting steels that are to be had, regardless of first cost so long as there is a possibility of greatly increasing production by rapid machining processes, it is surprising that more milling machines are not installed. A few American shops are now using millers on side rods, among them the Altoona shops of the Pennsylvania Railroad, where good results are being obtained, and this, together with the experience of English shops on similar work, is in itself proof of the economy of milling these over planing.

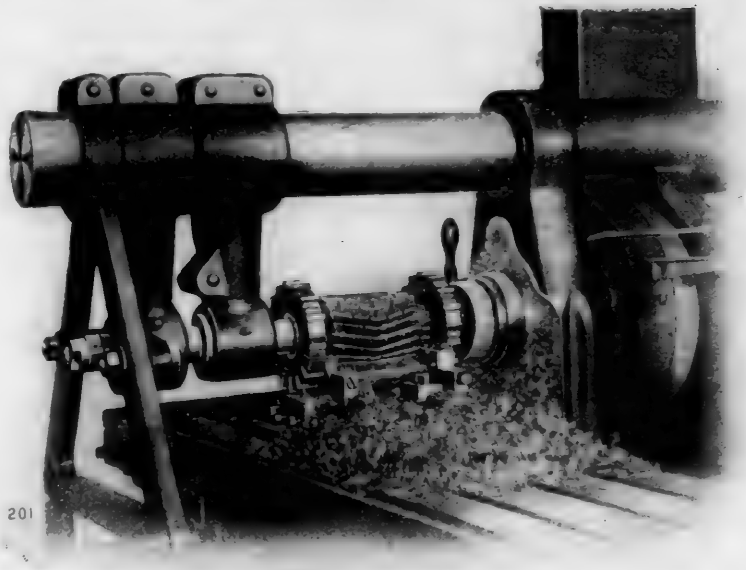

FIG. 1—METHOD SUGGESTED FOR MILLING DRIVING BOX SHOES.

In a great many American shops we have noticed milling machines used for sinking the end of flutes into the rods and the middle part was afterward planed out, the reason given being that while the planer could not finish the end of the groove in the rod, it could remove the metal from the middle section more rapidly than the milling machine. The reason for this must be that the planers used are better equipped for the work than the millers that happened to be in the shop. When such work is finished complete on a heavy miller, there should be a marked saving in time of the actual cutting operation, and in addition to this the time required for handling the piece from the miller to the planer would also be saved, so that altogether there should be at least a 25 per cent. saving by milling. For such work a heavy planer type miller is best adapted, and a machine should be selected large enough to mill several rods, placed side by side, at one time. The cutter arbor should be very large in diameter and well supported, and the cutters as small in diameter as it is possible to make them, and still have sufficient strength in the body to stand a heavy cut without splitting open. Since these cutters must necessarily have large round corners, and must be adjustable, so that their size may be maintained after repeated grindings, it is perhaps best to make them with inserted teeth, and these teeth should be alternately nicked to break up the chips. The body of the cutter should be made of machinery steel. Twenty feet per minute is a good basis for peripheral velocity of the cutters, and the feed should be limited only by the pulling power of the machine. In general, it may be said that fast feeds not only have the advantage of rapid production, but also materially reduce the tendency of the machine to chatter.

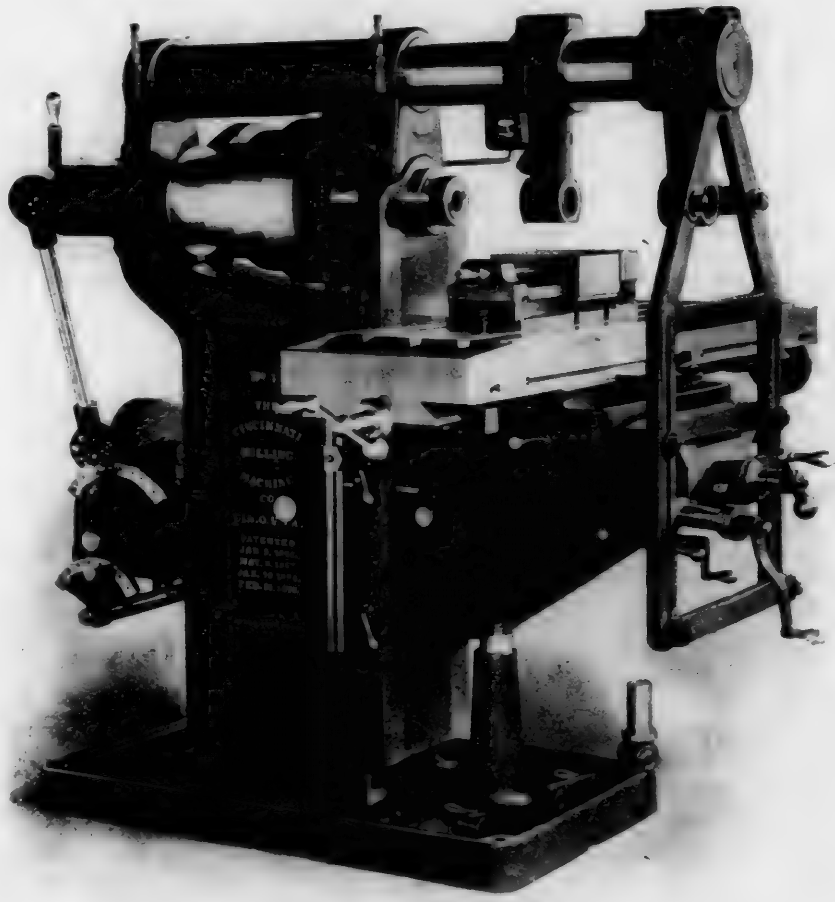

FIG. 3—NO. 4 PLAIN CINCINNATI MILLING MACHINE.

In addition to side rods, there are a large number of smaller parts which can be milled to good advantage—for instance driving-box shoes can be handled very nicely on the ordinary column and knee-type miller by using a gang of cutters and chucking the work, as shown in Fig. 1. This illustrates a No 4 Plain Cincinnati Miller on work of a very similar nature The casting is 8 ins. wide over all. The total width of the finished surface is 13 ins., and the largest cutters are 6 ins

in diameter. The depth of the cut runs from ⅛ to 3-16 in., the speed of the cutter is 33 r.p.m., and the table feed is 5½ ins. per minute without the slightest sign of chatter. This is indicative of the possibilities of these machines. It will be noted that the main body of the cutter is solid, has spiral teeth, and that these cutters are of the ordinary inserted tooth variety. Rod brasses and similar parts can be milled in the same manner at about twice the above rate.

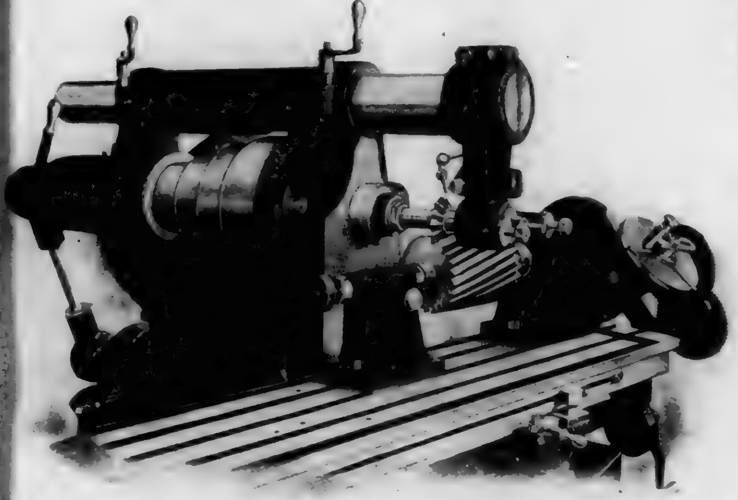

FIG. 2—MILLING A HEAVY SPIRAL CUTTER.

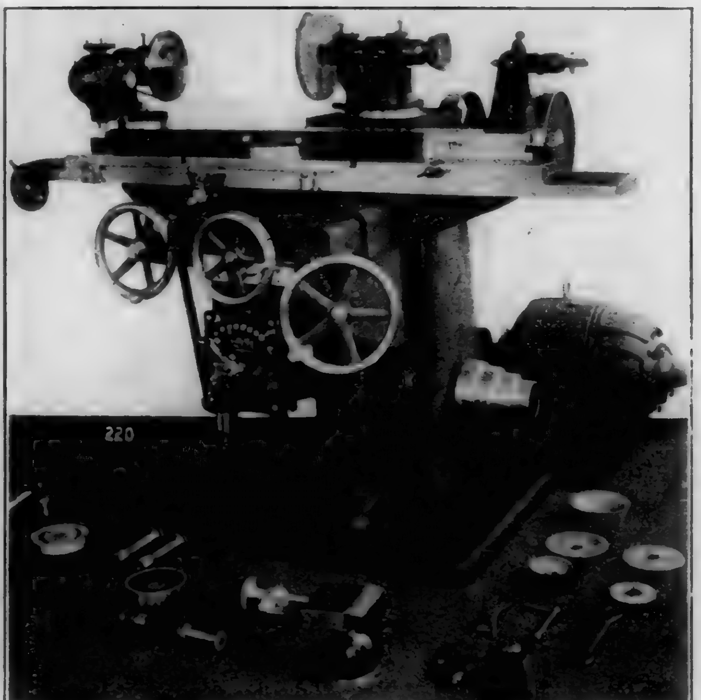

FIG. 4—NO. 2 CINCINNATI UNIVERSAL CUTTER AND TOOL GRINDER.

The time required for chucking the work on a miller is in no case more than that required for chucking it on a planer or shaper and working within the above practical limits of feeds, the gain is about 50 per cent. after due allowance has been made for maintenance of cutters. Of course, if milling is carried on to any great extent, it is necessary to provide the means for making and maintaining cutters, in other words, there must be an efficient tool room of ample size in connection with the machine shop, and here again practically all of the work can be done on milling machines with the single exception of the grinding operations. Fig. 2 is an interesting illustration of doing work in the tool room. This shows a No. 3 Universal Cincinnati Miller fitted with a head especially adapted to heavy spiral cutting. The blank is a piece of unannealed steel 5⅛ ins. in diameter, the flutes, being milled, are approximately ½ in. deep by ¾ in. wide at the top, and all the stock is removed by a single cut at a feed of over 1 in. per minute.

For ordinary slab-milling it is always desirable to use arbors of large diameter, and keep the diameter of the cutter as small as possible; therefore solid cutters will invariably give the best results, since the inserted tooth style must be comparatively large in diameter. Slabbing cutters should have the flutes spaced far apart, to give ample room for the chips, and they should not be milled too deep, so that they will have sufficient strength left for taking heavy cuts. The teeth should be alternately nicked so as to break up the chips, as

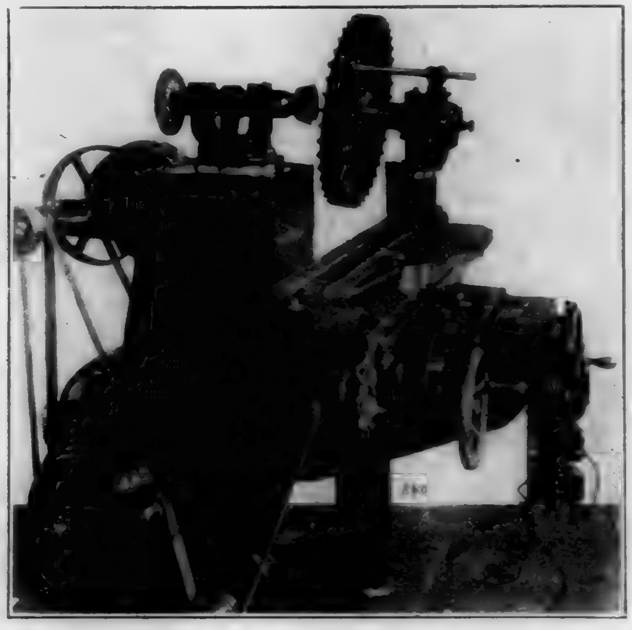

FIG. 5—SHARPENING THE SIDE TEETH OF A LARGE INSERTED TOOTH FACE MILL.

FIG. 6—SHARPENING A SPIRAL CUTTER.

this permits of faster cutting and greatly reduces the tendency to chatter.

An indispensable adjunct to the tool room miller is a convenient, simple and efficient grinder for keeping the cutters properly sharpened. The machine shown in Fig. 4 is adapted for grinding a variety of milling cutters that cover the complete range of cutters in practical use. Fig. 5 shows it in operation sharpening the side teeth of a large inserted tooth face mill. The teeth on the other side and also the peripheral teeth are sharpened in the same manner and with the same fixture without removing the cutter from the shank. It is

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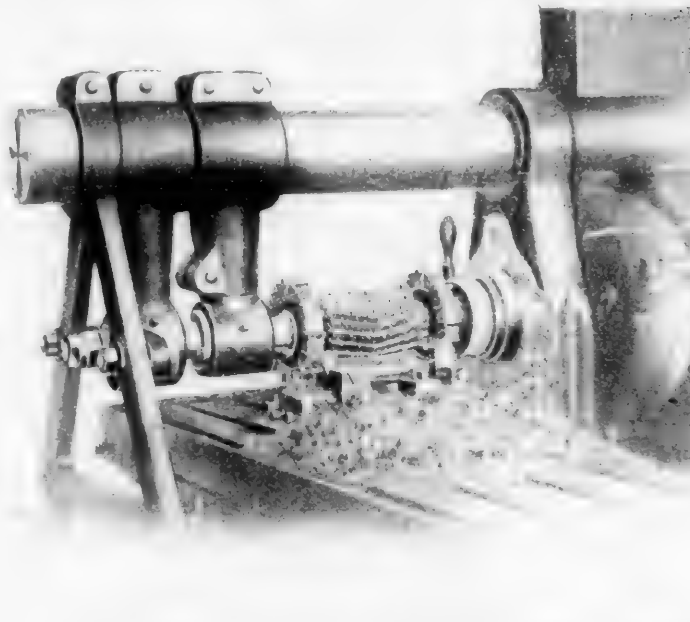
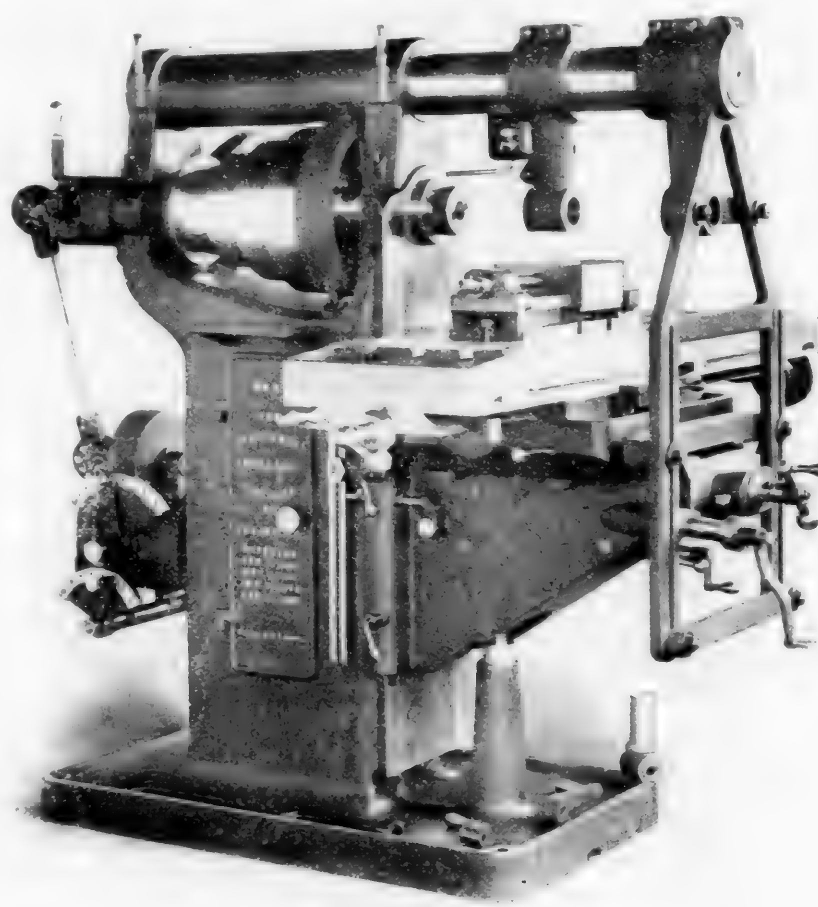


FIG. 1—METHOD SUGGESTED FOR MILLING DRIVING BOX SHOES.



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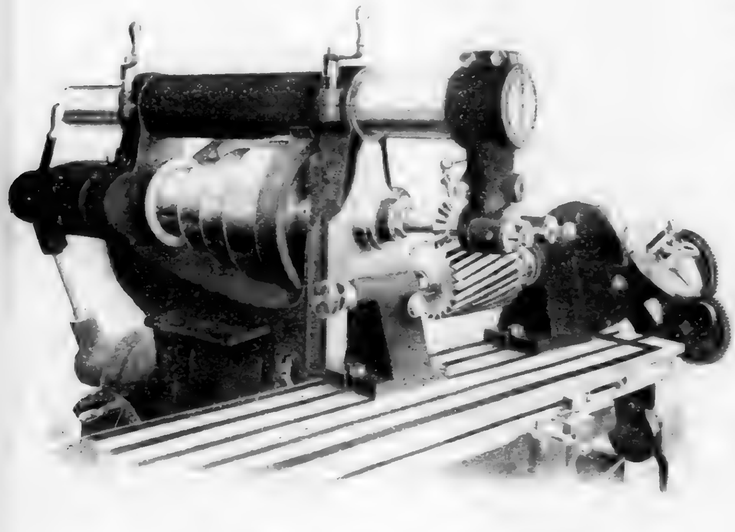
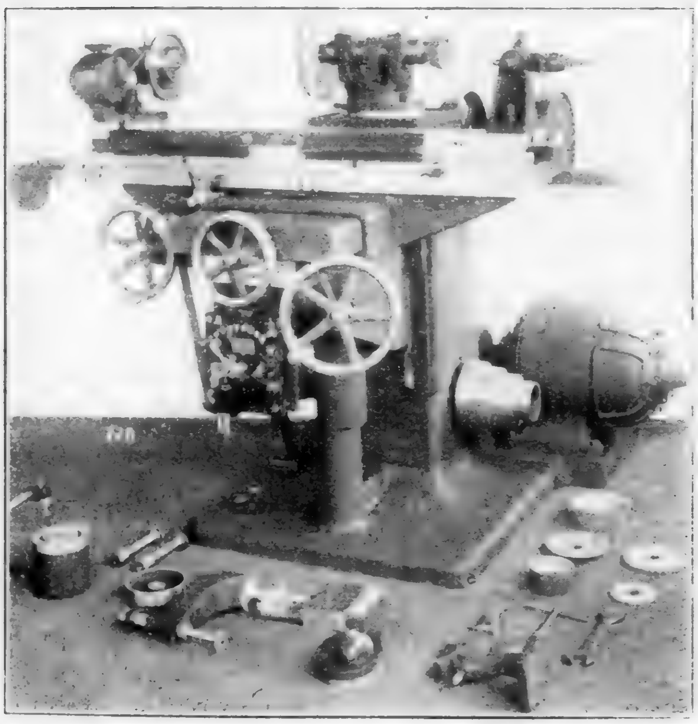


FIG. 2—MILLING A HEAVY SPIRAL CUTTER.



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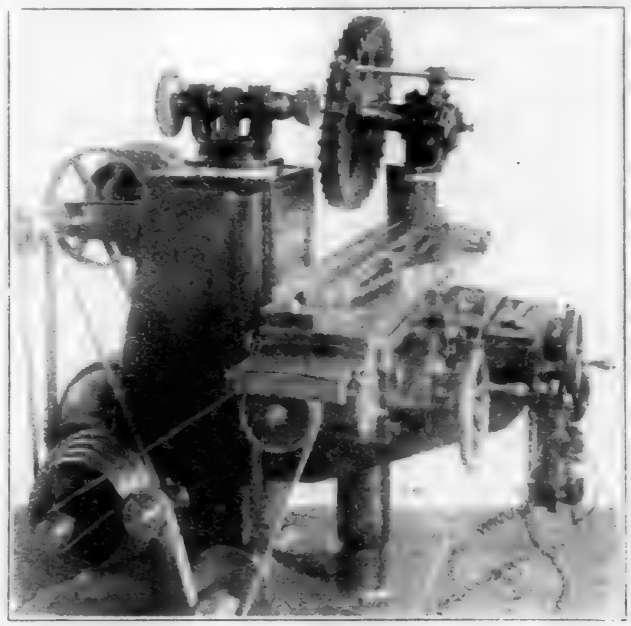
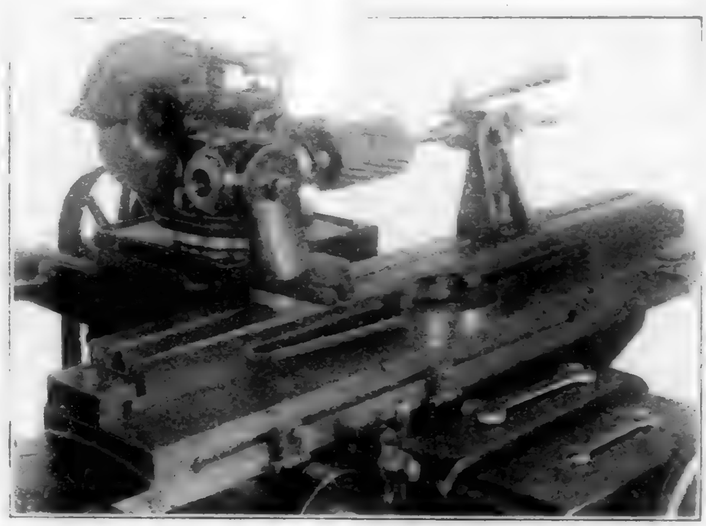


FIG. 5—SHARPENING THE SIDE TEETH OF A LARGE INSERTED TOOTH FACE MILL.



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held directly in the spindle of the head center of the grinder, so that while being ground, it revolves in a true plane about its axis and will therefore run true on its own arbor. This also applies to mills of smaller diameter, such as the ordinary end or butt mills, and these are held on their own shanks while being ground. The ordinary slabbing cutter is ground between centers, as shown in Fig. 6.

It will be noticed that in all of the above grinding operations a cup-shaped wheel is used. This is the proper method, as it gives a straight line clearance to the cutting edge instead of the cupped-out clearance that is obtained when the periphery of a disk wheel is used. In general, milling cutters will give the best satisfaction and their edges will last the longest if they are sharpened with an angle of about 5 degrees. In the case of end teeth of butt mills, or side teeth of large inserted tooth mills, this angle is obtained by setting the spindle of the index head to the desired angle, which may be read direct from a dial provided.

WATER SOFTENING.

Control and Results from a Chemical Standpoint.

BY G. M. CAMPBELL, P. & L. E. R. R.

The problem of softening water is not a problem of pure chemistry. Results on water passing through a softener at the rate of 60,000 gals. an hour, cannot be the same as those on a small laboratory sample where several days may be taken to make the reactions complete. Again, the materials used in water softening are not chemically pure, the labor is unskilled instead of highly trained, and the machine is subject to many limitations. When it is considered that even in a hard water the amount of material is extremely small—1 lb. of scale forming matter in 200 gals. of water would be an extremely hard water—and that the treatment is taken care of by unskilled workers who know absolutely nothing about the theory of chemistry, the results obtained with many softeners are indeed remarkable.

The title of this paper presupposes that water softening apparatus is in use; the softening of water by adding chemicals to the boiler or locomotive tender is entirely inadequate and inefficient. All water softening machines are not of the same value, some undoubtedly perform their work better than others, and it is poor economy to put in an inferior machine simply because the initial cost is somewhat lower. An inferior "continuous" softener, if used on a water of constant quality and of a uniform rate of flow, might work entirely satisfactorily because the necessary adjustments could be made to suit that one condition. But when the water varies widely in quality and supply, the mechanical mechanism of the machine must be as nearly theoretically and practically correct as possible, otherwise a badly fluctuating softened water will be the result. With a properly equipped and properly controlled continuous softener, results can easily be obtained in every respect equal to results with an intermittent machine, and at a very much less cost for labor and power, especially in the larger units, no matter what the quality or variation of the water.

After the machine has been chosen and installed it should be maintained in as good a condition as is possible; all adjustable devices should be carefully and regularly inspected. With the machine working at its maximum efficiency, everything depends on the proper proportioning of the treating chemicals to the quality of the water to be treated. With a water of unvarying quality, samples can be sent at intervals to a chemist and the resulting treatment based on his analysis. Many deep-well waters are fairly constant as far as scale-forming constituents are concerned, but even these waters vary in the amount of free carbonic acid present, which would require a change in the lime treatment. But with waters from rivers or shallow ponds or even shallow wells, the changes are far too rapid and uncertain to allow of successful treatment based on occasional full chemical analysis. Tests of the water at the time of treatment are absolutely essential; it is impossible to satisfactorily treat such waters otherwise. It is, of course, out of the question to maintain a chemist at each water softening plant to make the necessary analyses, consequently the tests must be so simple that the ordinary unskilled workman can understand them—not understand the reasons back of the tests, but be able to note certain results of the test and to intelligently base thereon his subsequent treatment. Owing to the inability of the ordinary workman to understand completely the chemical tests and the chemical reactions in the softener, he is incapable of drawing any correct conclusions as to what changes in treatment are required, if the treated water is not as it should be; consequently the treatment, in so far as quantities of chemicals required is concerned, should be beyond his control and he should not be held responsible for the quality of the treated water. He should be given definite written instructions, put in simple language, to make certain simple tests at stated times and to put in certain charges in accordance with his tests. He should also be held responsible for the mechanical working of the machine; but there his responsibility should end. This limiting of responsibility has one very good result—it removes from the attendant all desire to falsify records. The results of the treatment are, therefore, correctly given, and if these results are not sufficient, the necessary changes can be made in the charging tables or in method of testing and treatment.

With a number of water softeners all supplying water for one common purpose, such as may be found on a railroad, it is necessary that the water should be nearly uniform, and therefore it is necessary that the man ultimately in control should be kept fully informed as to what is happening at the various plants. The first step is to have regular reports sent him from each plant of the quality of the raw water, the quality of the treated water, the quantity of chemicals used, the amount of water pumped, etc. The work at any properly equipped pumping plant is such that the attendant can easily find time to make such report, provided easily understood blank report sheets are furnished him. The attendant may be painstaking and honest, but if he finds that his results go unchecked he will sooner or later become careless or inaccurate. Adequate check must therefore be provided, not in the nature of spying, but in the nature of records and samples, so that the attendant can easily see that he must sooner or later be detected in any inaccuracy or carelessness. The usual check on the attendants is to have an inspector make more or less regular visits to the plants to note conditions. Owing to the long distance between plants, especially on a railroad, the interval between visits would be long, and, moreover, there is no guarantee that the records and treatment are correct in the interim. A very satisfactory check is to have samples regularly collected and forwarded to some central point where they are checked by the inspector, not to make a full analysis, but simply the same tests as were made at the plant. Samples collected three times a week would usually be found quite sufficient. It is altogether improbable that, if the results are correct on Monday, Wednesday and Friday, the results on the other days would be incorrect; this is especially true if the samples of treated water are drawn from a storage tank. The results of these tests should be carefully compared with the records made by the attendant. Small discrepancies are to be expected; any large discrepancies should be noted and attendant asked to explain. If the number of plants is sufficient to warrant the expense, there should be assigned one man to test all these samples and at intervals to visit all the softeners, but more to look after the mechanical equipment than the chemical treatment; the chemical treatment can be accurately controlled from the central office and results definitely determined, and any departure from proper treatment can be easily detected. This is especially the case with varying river waters, as, owing to the rapid fluctuations and the general relation the results at one softener must bear to the results at the soft-

ener a few miles down stream, it is impossible for the attendant to so falsify records or to collect his samples that the error cannot be detected. If records are accurate and reliable, it is not at all a difficult problem to obtain any desired result. It would thus seem that rapidly varying waters could be very easily controlled, though this is contrary to common report. It must be borne in mind that, as stated before, such results on variable waters are obtainable only when the machine responds quickly to any change in treatment and when the feeding of chemicals is strictly proportionate to the amount of water pumped.

These general statements are based largely on the result of the control of the softening plants on the Pittsburgh & Lake Erie Railroad. There are ten plants in all, all installed by the Kennicott Water Softener Company: one has a capacity of 60,000 gals. an hour, five of 42,000 gals., three of 21,000 gals. and one of 15,000 gals. Several articles in connection with their installation and operation have already appeared in this journal. The machines have lent themselves admirably to the very severe conditions which are met with on the road. Of the ten softeners, only that at McKees Rocks is using well water; one, at Whitsett Junction, is using water from a shallow pond; the other eight use water from six different rivers. One plant is on the Youghiogheny River, two on the Monongahela, two on the Ohio, one each on the Beaver, Shenango and Mahoning. No two of these waters are the same, even the two on the one river differ considerably. Success with the varying river waters has been so satisfactory that the well at McKees Rocks is shortly to be abandoned and river water used. An average saving in chemicals alone of about $10 a day will be effected thereby. At Buena Vista, on the Youghiogheny River, the raw water, during the present summer varied in hardness from 5 to 48 deg., and as much as 10 deg. in one day, and varied from an alkalinity of 4 deg. to an acidity of 30 deg., and as much as 10 deg. in one day. Whitsett raw water, from a shallow pond, has varied in hardness from 16 deg. to 33 deg.; McKees Rocks, well water, from 36 deg. to 44 deg.; the others from about 5 to 25 deg. All these waters are brought down to an average of about 6 deg. in hardness, and an equivalent alkalinity and causticity. The conditions have been apparently very adverse, the waters very hard, acid and variable; yet the results have been satisfactory beyond question.

The various solutions used in connection with the testing at the softeners are as follows: Standard soap solution, fiftieth normal sulphuric acid, fiftieth normal sodium hydrate, methyl-orange indicator called "red indicator," and phenolphthalein indicator called "clear indicator." Results of all tests are expressed in equivalent parts of calcium carbonate per 100,000; the quantity of water taken for each test is such as to give that reading in cubic centimeters (c.c.); each part per 100,000 is called 1 deg. The general meaning and value of the tests need not be given here; they will follow later.

Identical testing and charging instructions are in force at all softeners and also almost identical charging tables when brought to the basis of 1,000 gallons treated; the amount of chemicals used is but little above the theoretical amount required, and the results obtained are, all things considered, remarkably uniform. Credit for this satisfactory condition is due, first, to the softener, and, second, to the general method of control which keeps all plants under strict supervision, yet with a minimum cost for inspection; the installation of these plants necessitated the addition of but one man to the company's payroll, a chemist or inspector. A small chemical laboratory was opened. This is not an absolute necessity, testing solutions could be purchased and simple tests could be made with a duplicate equipment to that at any of the softeners, but the small initial outlay, $250 to $300, would soon be saved in the manufacture of testing solutions and in making tests, which would otherwise have to be made at a regular laboratory. The work in the laboratory consists in the making of all testing solutions, such solutions being standardized against solutions of known strength, the making of partial analyses of any special samples of water from any source whatever, and the testing of the samples regularly sent in from the softeners. While the work is quite simple, yet it is advisable to have a technical man in charge. On roads where a regular testing laboratory is maintained, this work could very easily be taken care of.

The instructions to the softener attendant and the report sheets given in this article have special reference to the particular type of machine in use on the Pittsburgh & Lake Erie Railroad and to the general conditions on that road. Alterations could easily be made to suit any other conditions. At each softener there is a chemical cabinet which is about 33 ins. high, 28 ins. wide, 12 ins. deep and holds the complete testing outfit. This outfit now consists of: 3 25-c.c. burettes; 3 burette stands; 4 2-liter bottles with syphon attachment, containing respectively standard soap solution, standard soda solution, standard acid solution, and distilled water; 1 4-oz. round bottle; 2 8-oz. round bottles; 1 8-oz. square bottle; 2 dropping bottles, one containing what is called "red indicator," the other "clear indicator"; 1 100-c.c. graduated cylinder.

(To be continued.)

AWARDS TO PENNSYLVANIA RAILROAD

The remarkable display made at the St. Louis Fair by this road received fitting recognition from the juries of awards in the form of a large number of prizes and medals. A special commemorative grand prize was awarded for the series of scientific investigations of locomotive performance, and other prizes for the terminal station models, for the locomotive testing plant, and the other features of the collective exhibit. A grand prize was awarded to the Societe Alsacienne de Construction Mechaniques for the deGlehn compound locomotive, and gold medals were awarded to the collaborators in connection with the general exhibits and the locomotive testing plant. The members of the various committees and officials in charge of the testing plant were included in this appropriate recognition of the plant and its valuable work.

ECONOMICAL TRAIN OPERATION.

Mr. Henderson closes his series of four articles on train operation in this number. This important contribution to the literature of railroad operation is a result of the letters from railroad officials, printed in this journal last June, and Mr. Henderson's work places in the hands of general managers information which will help them through the next period of traffic congestion, which now seems to be rapidly approaching. It does this, and more. It suggests the necessity for a study of locomotive operation, which on very many railroads has never been made, and it should lead to a careful general investigation of the question, "What are your locomotives doing?"

MECHANICAL CONVENTIONS, JUNE, 1905.

The Master Mechanics' and Master Car Builders' Associations will hold their next conventions at Manhattan Beach, L. I., the Master Mechanics' Association occupying June 14 to 16, inclusive, and the Master Car Builders' Association, June 19 to 21, inclusive. Official headquarters will be in the Oriental Hotel. Information in regard to accommodations and rates may be secured from Mr. J. W. Taylor, secretary of the two associations, 658 Rookery building, Chicago.

STEAM HAMMERS VS. MEN.—I have been in a blacksmith shop for 35 years, and have never yet been able to get a man who is as strong as a steam hammer for making a weld. We go to the hammer with all of our eccentric rods and everything of that description. The men hesitate about welding up ⅞-in. round iron by hand. We have about eight fires to every hammer.—*Thomas Price, before National Railroad Master Blacksmiths.*

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

"AMERICAN ENGINEER" TESTS ON LOCOMOTIVE DRAFT APPLIANCES.

The announcement may now be made that the investigation began by this journal, the first record of which appeared on page 184, in June, 1901, is to be advanced and carried to completion through the aid of the American Railway Master Mechanics' Association.

On page 286 of the July number of last year will be found the report of the committee appointed by the Master Mechanics' Association to co-operate in these tests. This committee consisted of Messrs. H. H. Vaughan, F. H. Clark, R. Quayle, A. W. Gibbs and W. F. M. Goss. This report outlined the tests to be made, and stated their probable cost. The association authorized the executive committee to provide funds necessary to carry out the experiments, when money for such work became available, and the executive committee instructed the secretary to ask members of the association for contributions, which were obtained by the following letter:

"I am directed by the executive committee of the Master Mechanics' Association to ask the assistance of the railroad company which you represent in raising a sufficient fund to enable the association to carry to completion the tests on Locomotive Front Ends, which it has decided are necessary and desirable.

"The experiments carried on by the committee on this subject, which reported at the 1897 convention, decided some of the most important facts in connection with it, and its recommendations have been extensively adopted; but it was unable to complete its investigations, and in 1901 the AMERICAN ENGINEER AND RAILROAD JOURNAL, after considering carefully all the data so far obtained, organized a committee of those interested in the subject, which decided on the lines on which further tests should be directed. All possible assistance was rendered by Purdue University and several interested railroads, and sufficient money was furnished by the AMERICAN ENGINEER AND RAILROAD JOURNAL to carry on an extensive series of experiments.

"At the convention of 1902, the committee of the Master Mechanics' Association was appointed to assist the AMERICAN ENGINEER AND RAILROAD JOURNAL in carrying out these tests, and this committee was instructed to assist in the work and render financial assistance, if necessary, to complete the experiments, so that the laws governing this subject could be finally decided. The tests made at the expense of the AMERICAN ENGINEER AND RAILROAD JOURNAL were extensive, and the further experiments required related chiefly to the determination of the influence of varying diameters of front ends and the efficiency of draught pipes and diaphragms. The necessary series of tests were decided on, the loan of a suitable locomotive promised by the New York Central Railroad through the courtesy of Mr. Deems, and on behalf of Purdue University an offer was made of the free use of their Locomotive Laboratory and such co-operation of their permanent staff as they might find it possible to render. Under these conditions, the estimated cost of the proposed tests was $2,150.

"On application by the executive committee, it was found that it was unable, under the constitution of the association, to grant the necessary money, and, consequently, no work was done which could be reported to the 1904 convention. At the convention it appeared that the funds in the treasury were insufficient to justify the appropriation, and while another year may see the treasury in better shape, it was the opinion of the executive committee that this work should not wait. It is, therefore, in response to their suggestion that this appeal is made, with the hope that the railroad companies of the country will provide the necessary funds to carry on this most important series of experiments.

"I am pleased to advise that through Professor Goss, the committee on this subject has received a renewal of the offer involving the free use of the Purdue University laboratory which was previously made, and that the New York Central Railroad has expressed its willingness to furnish the locomotive required.

"Kindly let me hear from you at an early date, and use your best efforts to interest your company in this matter, which, I am sure, you will realize is of sufficient importance to justify a special appeal for assistance.

"J. W. TAYLOR, *Secretary*."

Mr. Taylor, in transmitting a copy of this letter, says: "I am pleased to state that the response has been very gratifying, that pledges for the full amount are in sight, and that the money will be received in a very short time to enable the committee to complete the tests as outlined in its report to the convention last year."

DEPARTMENTAL BENEFITS.

In the article by Mr. Henderson, on another page, emphasis is given to the importance of general, as distinguished from departmental, results in railroad operation. He quotes a railroad president as saying: "If one department can spend a dollar so that another department can save a dollar and one cent, the expenditure must be made, regardless of the fact that the spending department is increasing its expenses."

Mr. Henderson says this is too often overlooked in department jealousies, and we frequently hear officers say: "My department will not get the benefit of such an expense or improvement, and I am not going to increase my rolls." Superintendents, when an excess of power must be moved, sometimes send out one engine light, and a few minutes later another starts with an overload. This is done to increase the average train tonnage. The superintendent makes a good showing, but at the expense of the locomotives. He deceives himself by his bookkeeping, because he renders it impossible

for the motive power department to keep the locomotives up to their work.

Mr. Henderson touches lightly on this subject, but his articles present a method, whereby the general manager may reckon the cost of such practices, which are far too common. Motive power officers are helping the operating men far more than the operating men are helping the motive power department, and wise general managers will bring the department officials together in order to have the opportunities for the results of good team work fully understood. A school of railroad operation, attended about six times a year by operating, mechanical, maintenance of way and supply department officials, will do wonders for any railroad.

Locomotives are intended to haul trains effectively and cheaply, not merely to keep repairs down to a certain number of cents per mile. Trains are intended to handle passengers and freight efficiently and economically, not merely to show large tonnage per train. Bridges are for the support of the trains and locomotives which will reduce the cost of transportation to the lowest practicable figure, not to merely render the lives of the engineering department officers comfortable.

The motive power men are too generally required to bear burdens laid on them—perhaps unintentionally, perhaps ignorantly—by operating officers who permit overloading and unnecessary delays at stations, and by engineering department officers, who will not allow wheel loads which the bridges are perfectly able to carry with safety.

All this may be overcome by getting the officials together and permitting them to learn that they are not so much officers of departments as employees of the owners of the property.

Imagine the good which would result from a general study of the operation reports by all the officers concerned, say every two or three months!

BOSTON & ALBANY RAILROAD PROGRESSIVE ASSOCIATION.

The inauguration of this association of railroad employees, announced elsewhere in this issue, is important entirely out of proportion to its size and pretentions. It is a voluntary association, on an educational basis, of employees of the motive power department. The company provides quarters and the use of books, drawings and other helps available at the Allston shops. Manufacturers of railway appliances have freely responded to requests for drawings and models of locomotive auxiliary appliances. A course of lectures has been arranged for two evenings per month during the present winter and the membership, originally numbering eighteen, is steadily increasing.

Possibilities of truly great results lie before these men, and every railroad in this country should encourage the faintest sign of desire on the part of locomotive engineers, firemen and shopmen to advance by education, because the great men of this country are as a rule from the rank and file; and nowhere is there so promising a rank and file as on our railroads. It is the boys and men of the locomotives and shops who are prepared to educate themselves and are eager to take and even make opportunities for progress to whom we are to look for recruits for the leadership of the future. This Boston & Albany Association is small in itself, but it may be made a power of influence and advancement. The members do not dream of the good it may be made to do them and the community and the officials do not dream of the possibilities of improved efficiency through the educational development of thousands of men of the character and intelligence of those performing subordinate service on American railroads.

The esprit de corps of railroad employees and the faithful devotion which leads them, like those who follow the sea, to do difficult service for the love of it, should be considered thoughtfully by those who are responsible for railroad management of the immediate future. Education and progressive advancement of the men who run trains cannot be overlooked in plans for the future.

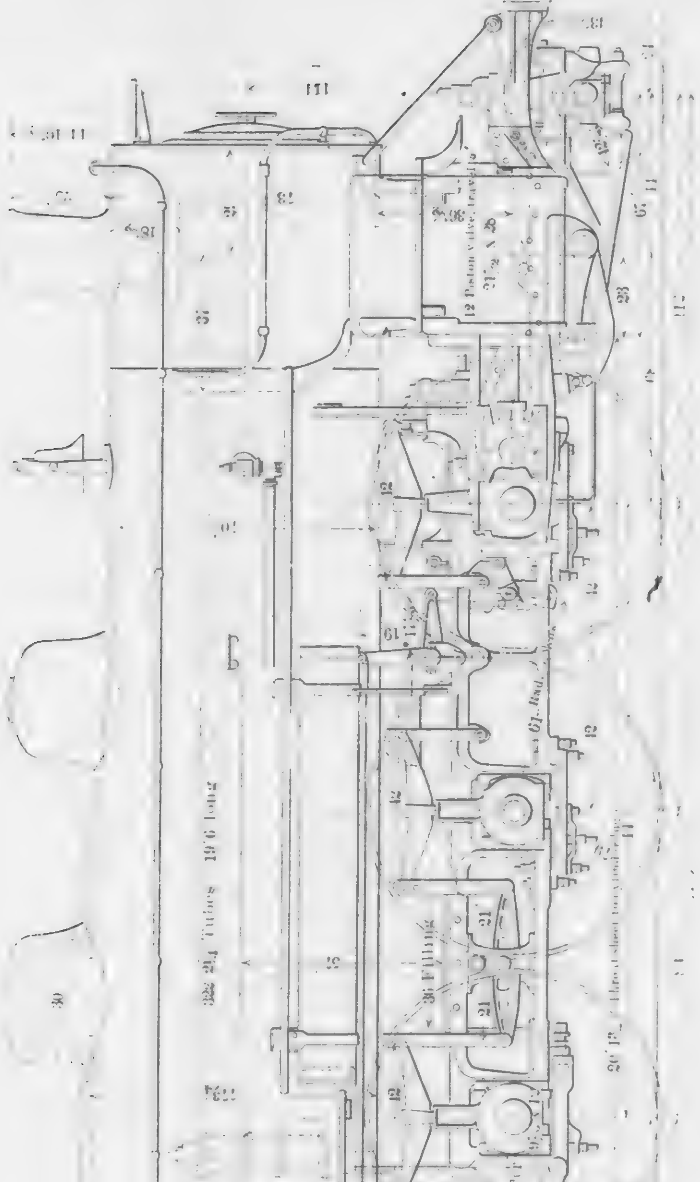
Why does not every American railroad hurry to provide facilities for this improvement when the men are ready, openarmed for them, and are prepared to do their part?

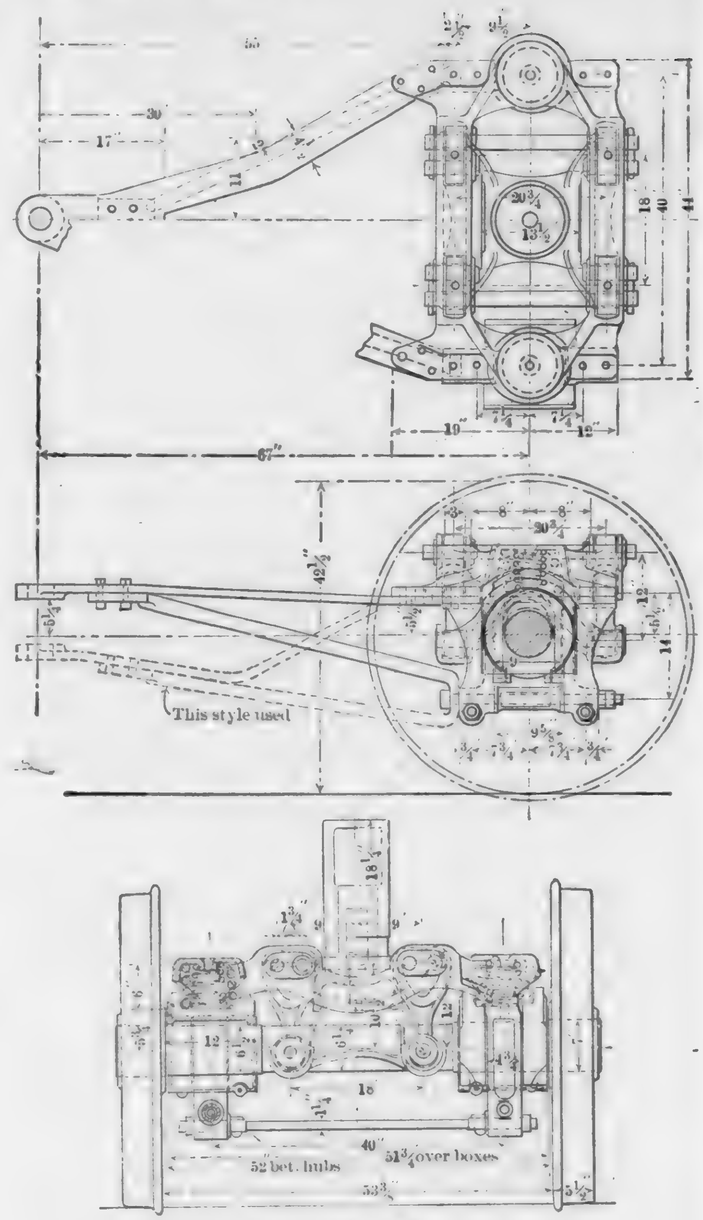
What can an educated engineer save? What can an educated fireman or shopman save? What can a thousand or two or ten thousand of them save?

This is an interesting period in American locomotive development. Never before has so much interest been shown in improved valve gear, superheating, four-cylinder balanced compounds, in the most favorable proportions of great area and heating surface. Everybody who is making any progressive steps is talking about them, and wondering how much there is in each of these factors. This is the time for the railroad mechanical engineer to show his value, especially on large roads and groups or systems of roads. When the railroads are building up their equipment so fast, to meet today's requirements, it is difficult to do any experimenting, but nevertheless experimenting should be done. A general manager told the writer that 54.4 per cent. of the locomotives on his road were new within the past five years. The total number now in service is over 650. That road has been wise in avoiding radical departures, but it will be unwise to delay longer an effort to ascertain the possibilities of improvements which now lay at hand waiting to be tried. Such a road should set its mechanical engineer to work embodying superheating and balanced compounding in new designs which will include as many as possible of the details at present in use, such as driving boxes, trucks and parts which are already in use and known to be satisfactory. Undoubtedly the locomotive builders would co-operate in work of this kind. In fact, they are doing so in certain well-known cases.

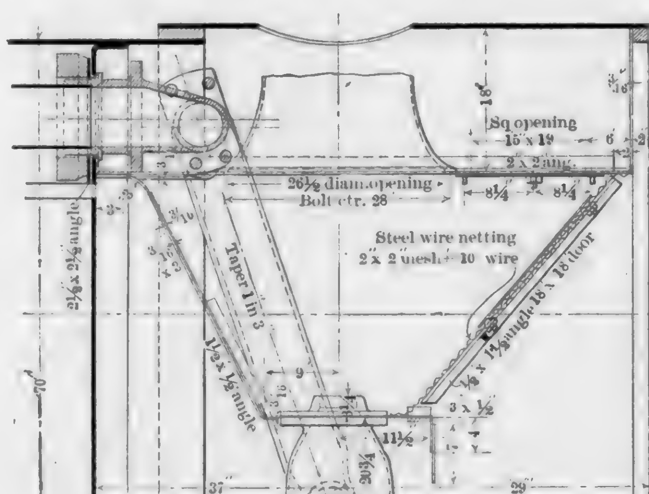
The problems of the organization and operation of a railroad blacksmith shop are very different from those met in the other departments. The foreman is to a greater extent thrown on his own resources and the success of the shop depends quite as largely on his ingenuity in devising special devices and tools, such, for instance, as can be used in connection with steam hammers and bulldozers, as on the proper handling of his men. The McKees Rocks blacksmith shop of the Pittsburg & Lake Erie Railroad is notable because of its large output, considering its size, and the low cost of production. The success of this shop is very largely due to Mr. McCaslin's method of handling the men and the special tools and devices which he has devised to increase the output and decrease the cost of production. Because of his success, the article by him in this issue will be specially valuable to those interested in this class of work.

The ten water softener plants on the Pittsburg & Lake Erie Railroad have been in service about a year with remarkable results. Because of the drought in the Pittsburg district, the river waters have become badly polluted by the refuse from the coal mines and mills. Although the other railroads in this district are having a great deal of trouble with their locomotives, because of the impure water, the Pittsburg & Lake Erie Railroad has had practically no trouble, and in fact has been able to loan power to less fortunate neighbors. The credit for this very satisfactory condition is due to the water softener used and to the general method of control, which keeps all these plants under a strict supervision, and yet with a minimum cost for inspection. The chemist, or inspector, was the only man added to the company's pay roll because of the installation of these plants. The system of control has been carefully worked out by Mr. G. M. Campbell, electrical engineer of the road, and this, with the results from a chemical standpoint, will be described in a series of articles by him, the first of which appears in this issue.





LEADING TRUCK.



"AMERICAN ENGINEER" FRONT END.

SIX-COUPLED PASSENGER LOCOMOTIVE, 2—6—2 (PRAIRIE) TYPE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

H. F. BALL, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*

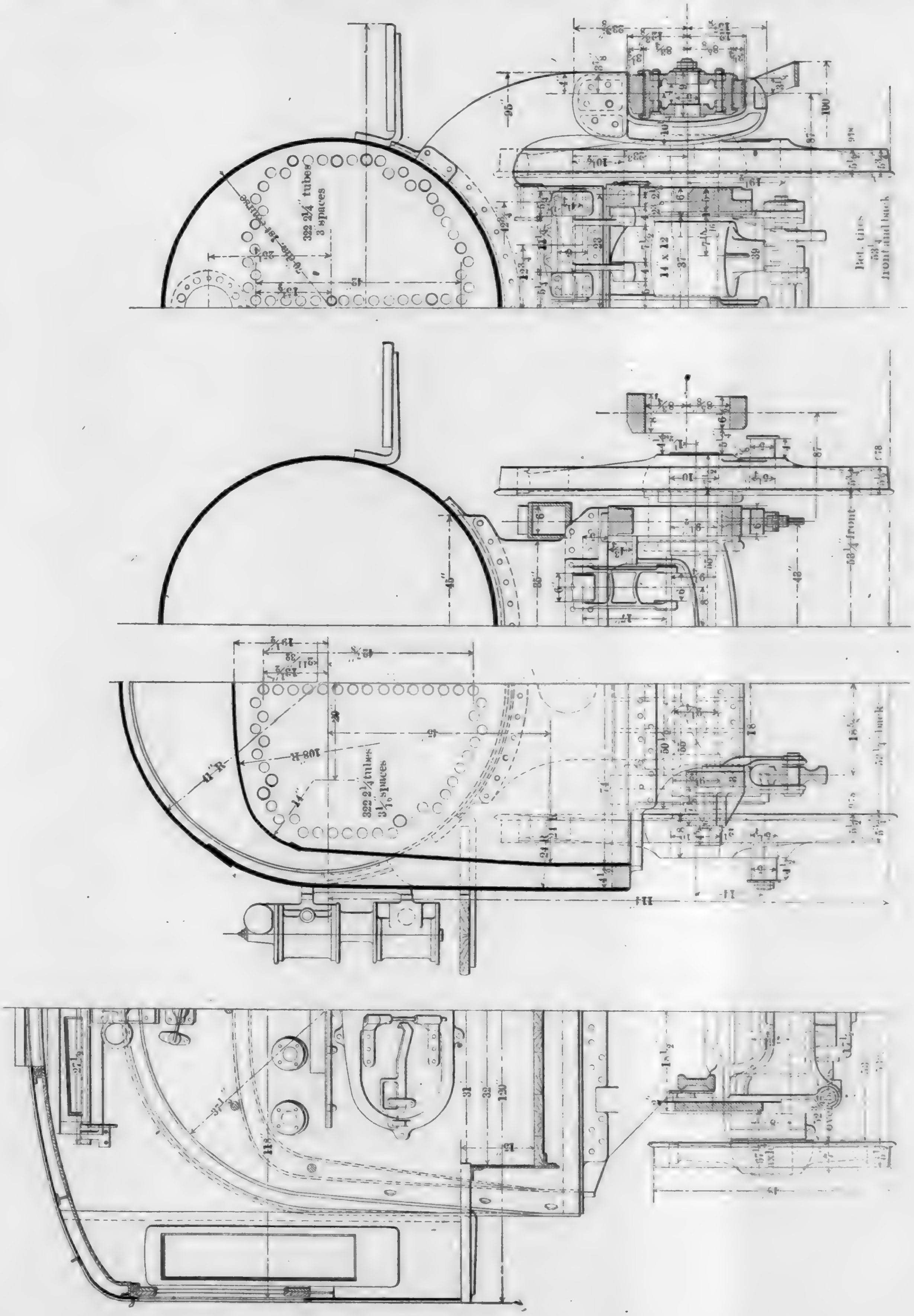
POWERFUL PRAIRIE TYPE LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

A general description of these locomotives appeared on page 413 of the November number, and a description of the frames on page 479 of the December number of this journal.

The accompanying engravings show a side elevation, sections, the leading truck, stack, and the arrangement of the front end. Little additional description is required, as the engravings explain themselves.

The cross sectional views show the construction of the guide yoke, rocker box, the rocker arms, the suspension for the transmission bar, and cross section of the equalizer under the firebox and the double fire doors, with one large opening through the back head. The large cast steel equalizer referred to is not symmetrical in section, as the lower or tension member of the I beam is larger than the upper or compression



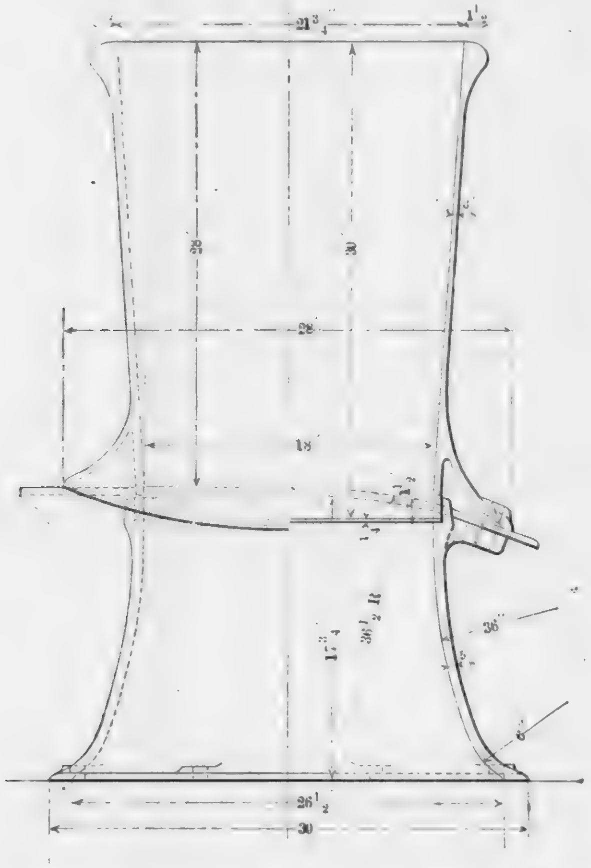
CROSS-SECTION THROUGH BOILER AND RUNNING GEAR.

SIX-COUPLED PASSENGER LOCOMOTIVE, 2—6—2 TYPE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

member, which is done for the purpose of decreasing the stresses per sq. in. in tension to an unusually low figure. These locomotives are fitted with 14-in. piston valves.

These locomotives are fitted with the Elvin grease lubrication for the driving boxes. The rod cups are also fitted with grease lubricators. The links are 3½ ins. wide and the valve motion stresses are in direct line with all pins in double shear. The leading truck, shown in one of the engravings, is made very compact and simple by the use of cast steel and by placing coil springs over the boxes. This truck has 8 ins. of lateral motion. The trailer truck is of the improved Player type with equalizers instead of leaf springs over the boxes. Coil springs are used at the rear ends of the equalizers and these are fitted with McCord spring dampeners. This truck gives space for an unusually good ash pan clearance. It provides a total lateral motion of 9 ins., which is required on account of the long wheel base.

The stack and front end are arranged in accordance with the AMERICAN ENGINEER tests on locomotive draft appliance, the results of which have thus far been very successfully applied on this road. The stack is shown in one of the illustrations. The boiler has an outside diameter of 70 ins. and has the gusset bracing, characteristic of the Brooks works. Tate flexible stay bolts to the number of 174 are used in the front and back corners of the fire box, all the throat stays and a number in the back head being of this variety. These locomotives have 322 2¼-in. tubes 19 ft. 6 in. long, with 13-16-in. bridges and 3 1-16-in. space at the back tube sheet. The spaces at the front tube sheet are 3 ins. Each engine is fitted with three standard blowoff cocks, one in each side and one in front of the firebox.



STACK DESIGNED ACCORDING TO "AMERICAN ENGINEER" FORMULA.

It is noteworthy that these locomotives weigh practically the same as the largest freight engines on this road, which were illustrated on page 12 of the January number, 1904. These locomotives have gone into service with excellent results thus far and promise to be very satisfactory.

NEW MOTOR SPEED CONTROLLER.

The rheocrat is a new type of motor speed controller, which may be used with any standard motor, and while its design is radically different from the ordinary type of controller, its size and external appearance are much the same, as will be noted by reference to the illustrations. Its principal advantages are the uniform and minute gradations of speed which it furnishes over a wide range, the ability to stand abuse under severe usage, its economy of operation, and the fact that the motor maintains its speed regardless of the load and that the torque is constant at the lower speeds over a range of about 3 to 1, which is obtained by changing the effective voltage at the motor. This range of 3 to 1 may be increased by the addition to the system of field control, thus permitting a range of speed of from 3½ to 1 up to 5 to 1, and even higher ratios in special cases.

The principle of the system consists, briefly, in the intermittent connection of the working circuit with the supply circuit. That is, in a cycle of operation, the supply circuit

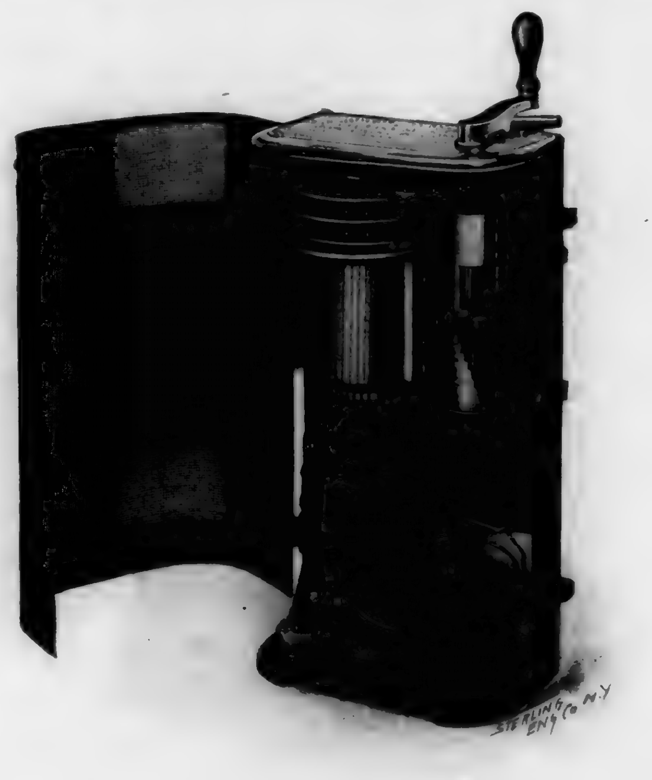


FIG. 1—5-H-P., TYPE A, RHEOCRAT.

is connected only a part of the time, the result being that the effective voltage at the motor, as measured by a voltmeter, is less than the supply voltage. The time of connection with the supply circuit can be varied, thus enabling the motor to be supplied from constant-potential mains with a voltage varying in value to accord to the speed desired. The rheocrat has been very severely tested for a considerable length of time, and the form shown in Fig. 1 has been adopted as standard. The essential part of the apparatus is the vertical commutator, which resembles closely the commutator of an ordinary dynamo. This commutator, or "interrupter," is driven by a small motor in the lower part of the case, and revolves at a constant speed of about 1,200 r.p.m. The terminals of the interrupter are at two groups of carbon brushes held in reaction brush holders, which are in contact with the interrupter along diametrically opposite lines. The supply circuit furnishes an impulse to the working motor only when a certain pair of bars, called contact bars, which are diametrically opposite but cross connected, pass under the collector brushes. By means of mechanism operated from the controller cylin-

der, any given number of these bars may be connected or disconnected to the pair of contact bars, thereby varying the length of time during which the supply circuit is connected with the motor circuit. The working limit of voltage variation by this means lies between the full voltage of the line and something less than half the voltage of the line, which latter voltage is given when the least number of bars are in circuit, and therefore when the time of interruption is longest.

A diagram of the wiring connections is shown in Fig. 2. The detached group of contacts to the right are for reversing the motor field. Of the two groups of contacts in line, the upper is for the interrupter control and the lower for the field control. The coil to the right represents a circuit-breaker acting directly as an under-voltage breaker, and also, through the relay shown at the left, as an overload breaker. Current cannot be put into the motor again after the opening of this overload switch without returning the handle to its off position. The overload release acts if the controller handle is moved too rapidly from its slow to its fast speeds, and so protects the motor from injury as a result of careless use.

In turning the controller handle from the starting point the following is the order of operations: First, the interrupter motor is cut into circuit; next, the working motor is connected with the supply circuit with its field winding directly across the circuit and the armature in series with the interrupter, of which only the first pair of contact bars is now active and the impressed voltage consequently a minimum, thus starting the working motor at the lowest speed. A further motion of the controller handle increases the impressed voltage, thereby increasing the speed of the working motor.

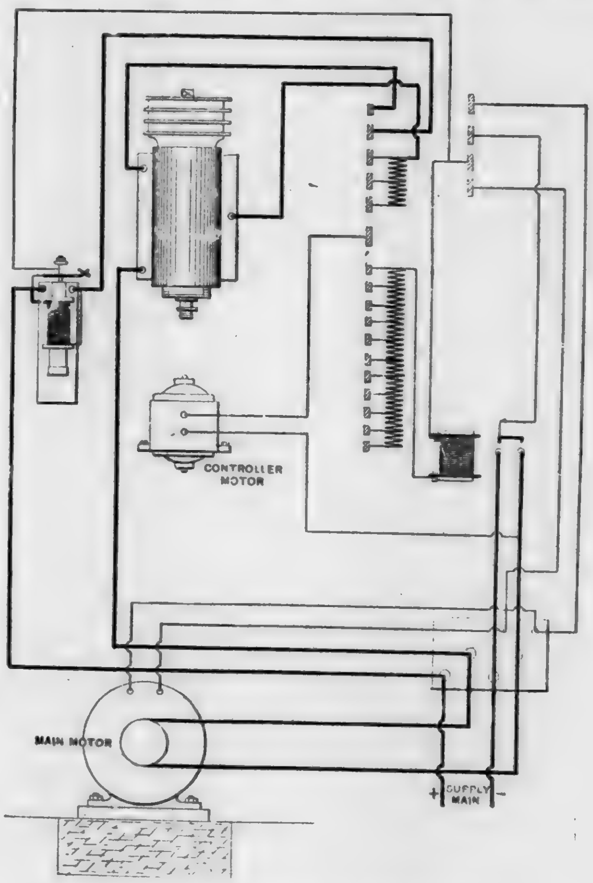


FIG. 2—WIRING DIAGRAM OF THE RHEOCRAT.

The next movement of the handle cuts out the interrupter, when the working motor runs on full line voltage. Further movement of the controller handle introduces resistance in the field circuit of the working motor, thereby increasing its speed, provided the working motor is designed for field control.

The design of the controller cylinder and interrupter is such that the changes in speed are made very gradually, and not by steps, causing abrupt changes. To provide for sparking at the brushes, which otherwise would take place upon the interruptions of the line connection, inductance coils connected between several of the narrow breaking segments in two groups, follow the pair of contact bars in passing under the contact brushes. In Fig. 1 these coils will be observed in the form of discs above the commutator or interrupter. By this means sparking is reduced to a negligible quantity. To reverse the motor, it is simply necessary to move a small switch, shown under the controller handle, to its opposite

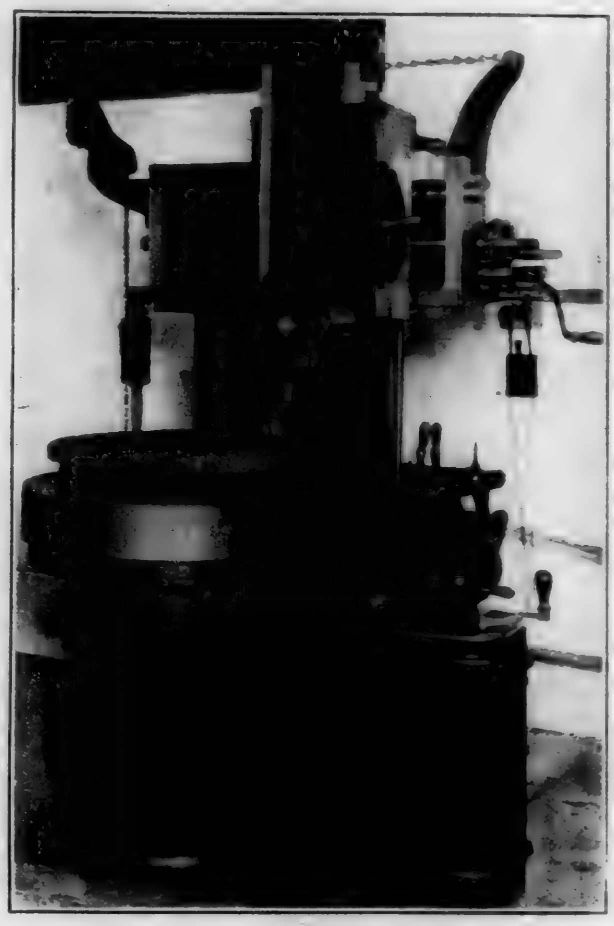


FIG. 3—31-IN. ROGERS MACHINE TOOL COMPANY BORING MILL AND RHEOCRAT.

position, when the entire speed range in the opposite direction becomes available. The reversing switch is interlocked with the main controlling cylinder, so that it cannot be thrown except when the controller handle is at the off position.

The rheocrat can be used with any standard motor and with any system of wiring. A separate starting box and circuit breaker or overload release are not required, as these features are embodied in the controller itself. On such machine tools as lathes and boring mills, a constant torque is very desirable; for instance, it may be necessary to do a job of facing on a lathe, and while the size of the cut will remain the same, in order to keep the cutting speed constant, and thus obtain the greatest efficiency from the machine, the motor speed may have to be varied over a wide range. The close regulation which can be obtained by the use of the rheocrat is shown by the following tests.

These were made on a 31-in. Rogers Machine Tool Company boring mill, shown in Fig. 3, driven by a General Electric 3-h.p. motor and rheocrat controller. Armstrong-Whitworth "A. W." high speed tool steel was used.

TEST 1.

Heavy cast iron flange, 15¼ ins. diameter faced to 8 ins. diameter.
Time required, 3 min. 38 sec.
Maximum cutting speed, 125 ft.
Minimum cutting speed, 115 ft.
Average cutting speed, 120 ft.
Feed, 48 cuts per in. Depth of cut, ⅛ in. 3.42 h.p. at boring mill pulley.
Estimated h.p. input about 3.73 (electrical.)

member, which is done for the purpose of decreasing the stresses per sq. in. in tension to an unusually low figure. These locomotives are fitted with 14-in. piston valves.

These locomotives are fitted with the Elvin grease lubrication for the driving boxes. The rod cups are also fitted with grease lubricators. The links are $3\frac{1}{2}$ ins. wide and the valve motion stresses are in direct line with all pins in double shear. The leading truck, shown in one of the engravings, is made very compact and simple by the use of cast steel and by placing coil springs over the boxes. This truck has 8 ins. of lateral motion. The trailer truck is of the improved Player type with equalizers instead of leaf springs over the boxes. Coil springs are used at the rear ends of the equalizers and these are fitted with McCord spring dampeners. This truck gives space for an unusually good ash pan clearance. It provides a total lateral motion of 9 ins., which is required on account of the long wheel base.

The stack and front end are arranged in accordance with the AMERICAN ENGINEER tests on locomotive draft appliance, the results of which have thus far been very successfully applied on this road. The stack is shown in one of the illustrations. The boiler has an outside diameter of 70 ins. and has the gusset bracing, characteristic of the Brooks works. Tate flexible stay bolts to the number of 174 are used in the front and back corners of the fire box, all the throat stays and a number in the back head being of this variety. These locomotives have 322 $2\frac{1}{4}$-in. tubes 19 ft. 6 in. long, with 13-16-in. bridges and 3 1-16-in. space at the back tube sheet. The spaces at the front tube sheet are 3 ins. Each engine is fitted with three standard blowoff cocks, one in each side and one in front of the firebox.

STACK DESIGNED ACCORDING TO "AMERICAN ENGINEER" FORMULA.

It is noteworthy that these locomotives weigh practically the same as the largest freight engines on this road, which were illustrated on page 12 of the January number, 1904. These locomotives have gone into service with excellent results thus far and promise to be very satisfactory.

NEW MOTOR SPEED CONTROLLER.

The rheocrat is a new type of motor speed controller, which may be used with any standard motor, and while its design is radically different from the ordinary type of controller, its size and external appearance are much the same, as will be noted by reference to the illustrations. Its principal advantages are the uniform and minute gradations of speed which it furnishes over a wide range, the ability to stand abuse under severe usage, its economy of operation, and the fact that the motor maintains its speed regardless of the load and that the torque is constant at the lower speeds over a range of about 3 to 1, which is obtained by changing the effective voltage at the motor. This range of 3 to 1 may be increased by the addition to the system of field control, thus permitting a range of speed of from $3\frac{1}{2}$ to 1 up to 5 to 1, and even higher ratios in special cases.

The principle of the system consists, briefly, in the intermittent connection of the working circuit with the supply circuit. That is, in a cycle of operation, the supply circuit

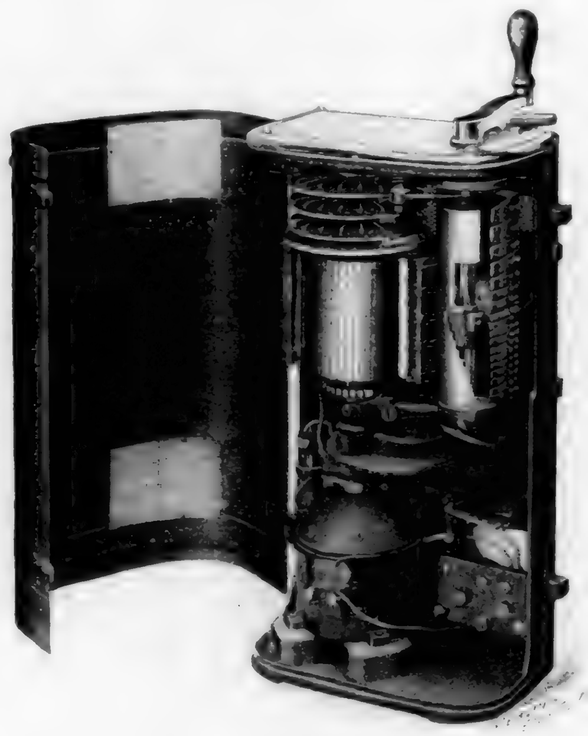


FIG. 1—5-H.-P., TYPE A, RHEOCRAT

is connected only a part of the time, the result being that the effective voltage at the motor, as measured by a voltmeter, is less than the supply voltage. The time of connection with the supply circuit can be varied, thus enabling the motor to be supplied from constant-potential mains with a voltage varying in value to accord to the speed desired. The rheocrat has been very severely tested for a considerable length of time, and the form shown in Fig. 1 has been adopted as standard. The essential part of the apparatus is the vertical commutator, which resembles closely the commutator of an ordinary dynamo. This commutator, or "interrupter," is driven by a small motor in the lower part of the case, and revolves at a constant speed of about 1,200 r.p.m. The terminals of the interrupter are at two groups of carbon brushes held in reaction brush holders, which are in contact with the interrupter along diametrically opposite lines. The supply circuit furnishes an impulse to the working motor only when a certain pair of bars, called contact bars, which are diametrically opposite but cross connected, pass under the collector brushes. By means of mechanism operated from the controller cylin-

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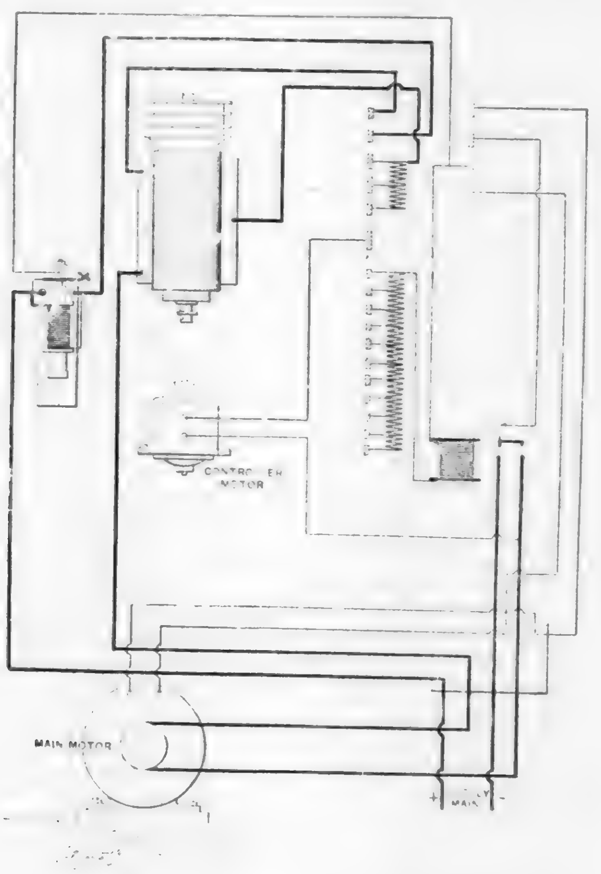

FIG. 2. WIRING DIAGRAM OF THE RHEOCRAT.

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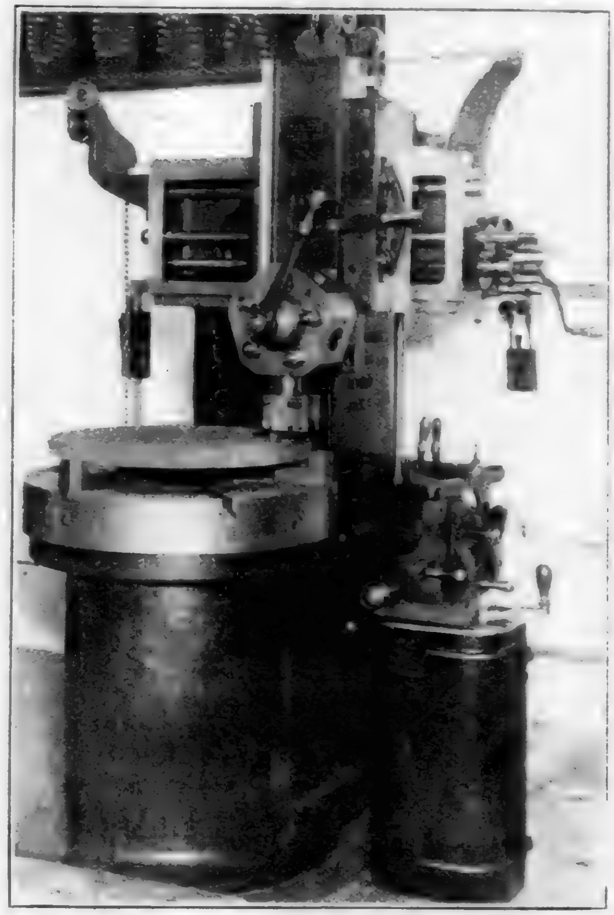

FIG. 3.—31-IN. ROGERS MACHINE TOOL COMPANY BORING MILL AND RHEOCRAT.

position, when the entire speed range in the opposite direction becomes available. The reversing switch is interlocked with the main controlling cylinder, so that it cannot be thrown except when the controller handle is at the off position.

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TEST 1.

Heavy cast iron flange, 15½ ins. diameter faced to 8 ins. diameter.
Time required, 3 min. 38 sec.
Maximum cutting speed, 125 ft.
Minimum cutting speed, 115 ft.
Average cutting speed, 120 ft.
Feed, 48 cuts per in. Depth of cut, ⅛ in. 3.42 h.p. at boring mill pulley.
Estimated h.p. input about 3.73 (electrical.)

TEST 2.

Standard cast iron pipe flange, faced 15½ ins. to 9 ins. diameter.
Time required, 2 min. 8 sec.
Maximum cutting speed, 78 ft.
Minimum cutting speed, 72 ft.
Average cutting speed, 75 ft.
Feed, 16 cuts per in.
Depth of cut, ⅛ in. Same tool used as in No. 1 test without being reground.
6.1 h.p. input to motor (electrical).
4.92 h.p. delivered to the boring mill pulley.

TEST 3.

Outside diameter, 24½ ins., faced to a diameter of 12¾ ins.
Time required, 8 min. 58 sec.
Maximum cutting speed, 125 feet per min., momentarily only. Reduced because the motor would not stand the excessive overload.
Reduced maximum cutting speed, 102 ft. per minute.
Minimum cutting speed about 98 ft. per minute.
Average cutting speed, 100 ft. per minute.
Feed, 16 cuts per in. Depth of cut, ⅛ in.
Tool uninjured.
6.44 h.p. input to motor (electrical).
5.28 h.p. delivered to boring mill pulley.

The rheocrat is made by the American Electric & Controller Company, 12 Dey street, New York City, of which J. D. Maguire is president and Elmer A. Sperry, consulting engineer.

THE BALTIMORE & OHIO CAST IRON WHEEL.

Those present at the Master Car Builders' convention last June will remember the discussion by the Baltimore & Ohio representatives of the report of the committee on cast iron wheels (see AMERICAN ENGINEER, July, 1904, page 287). In response to a request, Mr. J. E. Muhlfeld, general superintendent of motive power of that road, has supplied drawings and information for a description of the Baltimore & Ohio design of 33-in., 750-lb. wheels for 50-ton cars.

The Baltimore & Ohio officers consider that this design meets the requirement of severe service, under conditions of operation and braking of large capacity cars, better than any other, "and where the Master Car Builders' Association recommended design has failed."

The chief characteristics of this design are the arrangement and location of the plates, the contour of the tread and the increased depth of metal in connection with the reinforcement of the brackets at the back of the flange. The tread is slightly conical, and this has been found to eliminate flange wear to a considerable extent on steel-tired wheels. When flange wear is prevented, the stresses in the flange are to a large extent decreased, which tends to eliminate the development of seams at the throat of the flange, due to flange friction and the heating of the wheel in curving. The plates are made to join the tread at the outer rim at an angle, and not in a direct plane of the wheel. The angularity of the plate and the corrugation render the plate more flexible, and to a large extent prevent the cracking of the plate from the heat of the brake shoes. The plate and the large amount of metal brought to the outer edge of the rim answers a three-fold purpose:

First—It prevents the outer edge of the rim from chipping off.

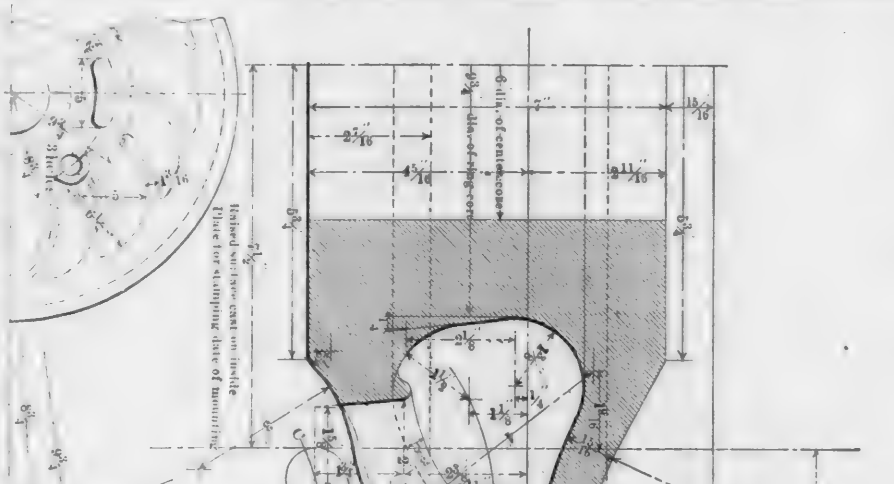
Second—The body of metal prevents the wheel from being completely chilled at this point, where the chilling effect is not needed.

Third—The body of metal at this point, where the brake shoe happens to become shifted over the edge of the wheel and applied, takes off the heat from this portion of the wheel and prevents cracking in the tread, which is produced in the M. C. B. type of wheel under similar conditions.

Another feature is that the reduced metal above the rail contact increases the chilling effect where the greatest wearing capacity is desired, and the increased metal at the back and base of the flange and at the rim reduces the chilling effect where less wear and greater strength of metal are required to take care of the brake shoe and flange friction. This wheel is well braced by the brackets at the back of the flange, and increased metal is provided at this point, which tends, not only to strengthen the flange, but also to draw the chill and back up the throat of the flange with more gray iron.

To show the benefit of the plates as arranged in this design with regard to withstanding the braking effect, a number of cars, which were extremely hard on wheels because of large weight per wheel, were equipped with wheels of this design. These wheels in going down very heavy grades were burned on the treads in a short time, the chill became disintegrated and large pieces fell out; but out of the wheels under 20 cars none were cracked. Later, these wheels were replaced by others of the M. C. B. design, and immediately many of them had to be removed on account of cracked plates.

This road has, for a number of years, used wheels of a de-



THE BALTIMORE & OHIO CAST IRON WHEEL.

sign similar to the one illustrated, with the exception of the contour of the tread, and the number of cracked plates was small. Those which cracked were extremely hard. This new design has been in service since February, 1904, and at the end of September, 1,000 of them were in service. This is now the standard wheel of the Baltimore & Ohio Railroad. This tread contour has been used on locomotive tires for the past year

with very satisfactory results. The cast iron wheels with this contour have not been in service long enough to give sufficiently definite information. Further tests are being made by equipping 50-ton steel hopper cars with four B. & O. design wheels under one truck and four M. C. B. wheels under the other. Similar tests, comparing B. & O. cast iron and rolled steel wheels, will be made.

Because of the severity of its service, this study of wheels on the Baltimore & Ohio is exceedingly important, promising valuable information on the problem of wheels under heavy cars.

HOLLOW HEXAGON TURRET LATHE.

A powerful turret lathe, which is designed for using the high speed tool steels up to the limit of their efficiency, is shown in Fig. 1. It takes bar stock up to 3⅝ ins. in diameter, will turn up to 36 ins. in length and has a swing of 24 ins. over the bed. In addition to its great strength and rigidity, the most noticeable features are the wide range of speeds and feeds which are instantly changeable, the rapidity and convenience of manipulation and the improved high speed turning tools.

When belt driven, 12 spindle speeds are provided, ranging from 18 to 190 r.p.m. in geometrical progression and giving about 100 ft. surface speed on diameters from 2 to 3⅝ ins. advancing by eighths. The belt cone is geared 3½ to 1 and back geared 13 to 1; the back gears being engaged and disengaged by friction clutches. The machine illustrated is driven by a Bullock 3 to 1 motor, direct connected to the back gear shaft, and rated at 15 h.p. The head and bed of the lathe are cast in one piece.

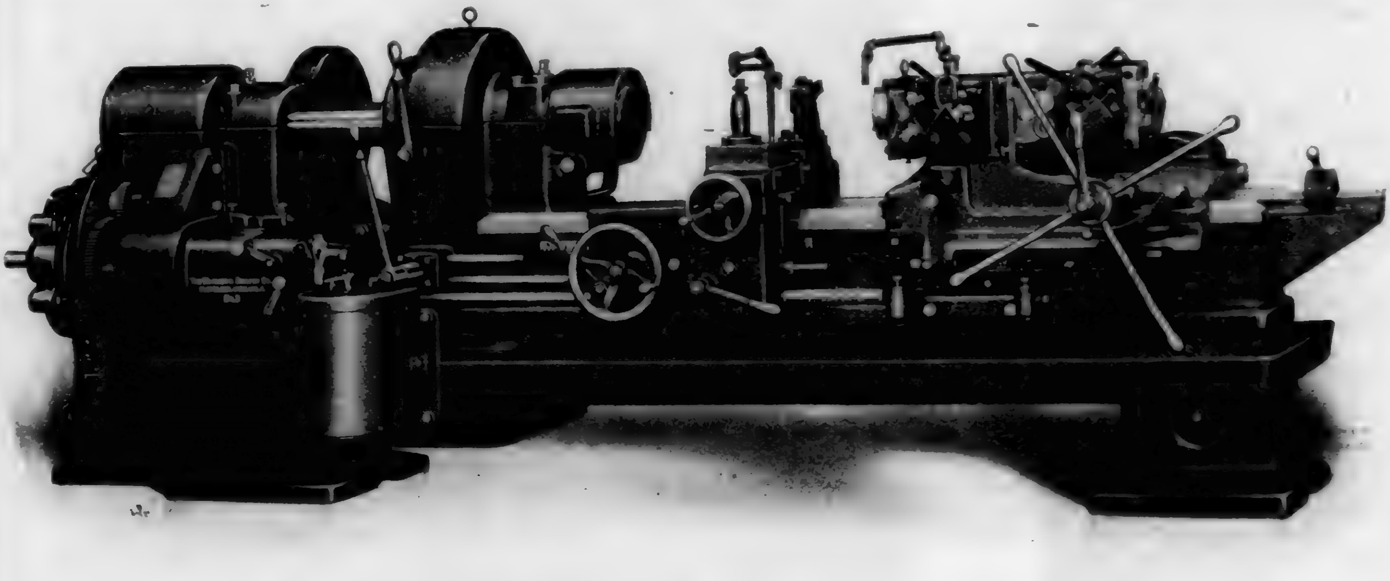


FIG. 1—NO. 3 HOLLOW HEXAGON TURRET LATHE.—WARNER & SWASEY COMPANY.

Bar stock of any shape is handled by the automatic chuck and power roller feed. The chuck is held in the head of the spindle, which is forged solid, thus bringing the chuck jaws close to the front spindle bearing with a minimum of overhang. The chuck is operated by the long lever in front of the head, working through a system of compound levers, which give a powerful movement for closing the jaws. The jaws are quickly changed for different diameters of stock, and a single screw adjusts the roller feed and the guide fingers. The roller feed is operated by the same lever as the chuck, and since it does not depend upon the spindle for its power, the stock can be fed equally well at any speed.

The turret saddle slides directly on the bed, eliminating all overhang. It is gibbed to the outer edge of the bed by flat gibs throughout its entire length. There are four changes of feed in either direction, varying from 20 to 100 per in., and screw-cutting feeds for leading on dies. The feed rack is located on top of the bed midway between the V's and is as high up as possible, thus greatly reducing the stresses as compared to those in the construction where the rack is placed at the side of the bed. The automatic feed is thrown in or out by the single curved lever at the right of the saddle near the turnstile. Power quick traverse in either direction is provided for the rapid handling of the turret, and for indexing, the movements being controlled by the lever in front of the turnstile. The independent adjustable stops for each face of the turret are located in front of the saddle, where they are easily accessible for changing and adjusting, and at the same time are well protected from chips and dirt.

The hollow hexagon turret, shown in Fig. 3, is 18 ins. across the flats and has a broad bearing on the carriage. It revolves on and is kept central by a large taper bearing, with ample provision for taking up wear, and its trussed form provides a rigid support for the tools, resisting end thrust as well as torsional strains. The turret being hollow, allows tools to be

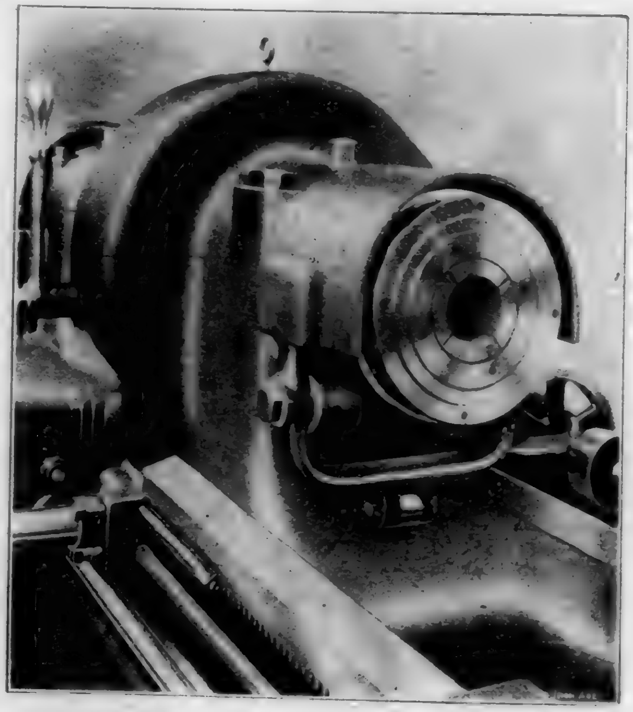


FIG. 2—SPINDLE END AND AUTOMATIC CHUCK.

bolted in place from the inside, thus leaving the entire outer surface available for tools and their parts. The index is nearly the full diameter of the turret, and the lock bolt is placed directly under the working tool. The backward movement of the saddle gives the turret its partial revolution, which begins as soon as the working tool is free from the stock. The adjustable stop shown at the extreme tail end of the machine is clamped to the feed rack and governs the position of the saddle at the time when the turret begins to revolve.

The tool equipment regularly furnished is adapted for a great variety of work, including thread-cutting. The universal turners are especially adapted for using high speed tool steels. One of the special features of the tool is the roller back rest, shown in Fig. 4, which eliminates the excessive friction due to the high speeds, and the improved construction and great rigidity of the tool insure the highest degree of accuracy. The holder which carries the cutting tool swings about a stud, and can be easily and accurately adjusted by means of a screw, while an eccentric lever provides means for quickly withdrawing the tool from the work.

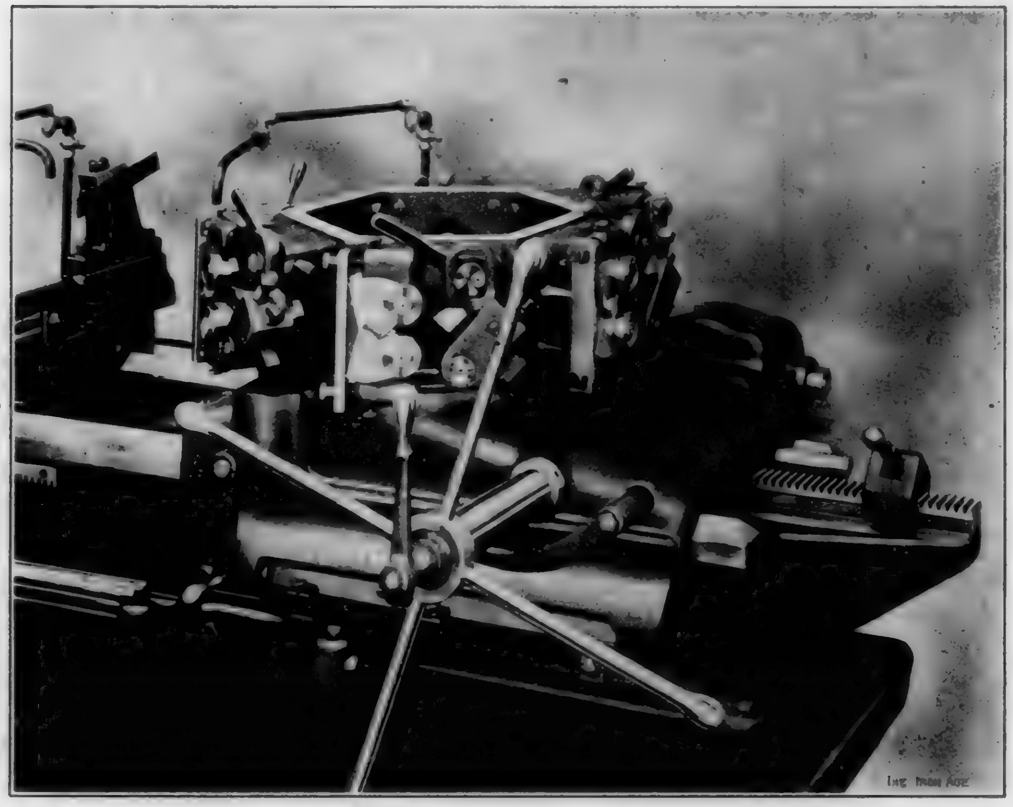


FIG. 3—HOLLOW HEXAGON TURRET AND TOOL EQUIPMENT.

The carriage has 30 ins. traverse longitudinally and 10 ins. cross motion, both with four changes of feed in either direction. The longitudinal feeds vary from 24 to 120 and the cross feeds from 62 to 312 per in. Both feeds have adjustable automatic trips. There are 2 stops, with automatic trips, for the longitudinal travel, and the cross feed screw is fitted with a graduated dial. The front of the cross slide is equipped with a suitable tool post for holding forming and turning tools, while the rear end carries a holder for cutting-off blades. All of the feeds are gear driven, and are quickly and easily changed by simply shifting a lever in the feed box, which is conveniently located in front of the head, and is shown in Fig. 5. The turret and carriage feeds are independent of each other.

The pan and oil revervoir are large, and a geared oil pump, which operates in either direction, delivers a copious flow of oil to the cutting tools for both the turret and carriage, through two systems of piping. All gears and other revolving parts are covered by suitable metal guards.

This machine, which has a net weight of about 12,000 lbs., is made by the Warner & Swasey Company, of Cleveland. It is known as No. 3 and is the largest of three sizes of hollow hexagon turret lathes made by them.

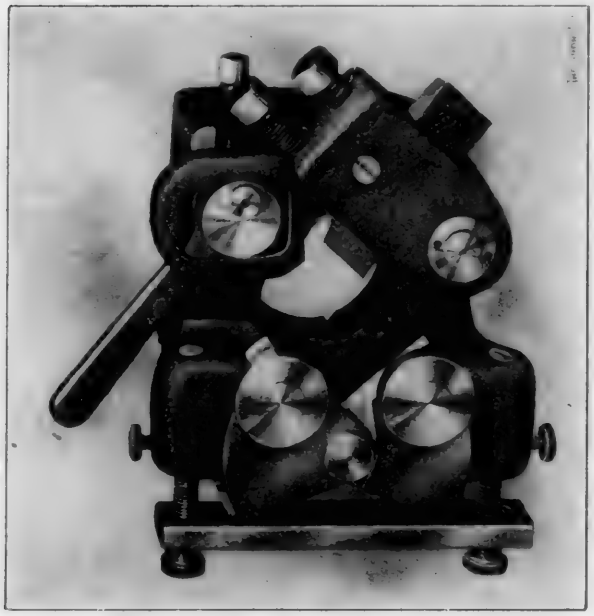


FIG. 4—UNIVERSAL TURNER WITH ROLLER BACK REST.

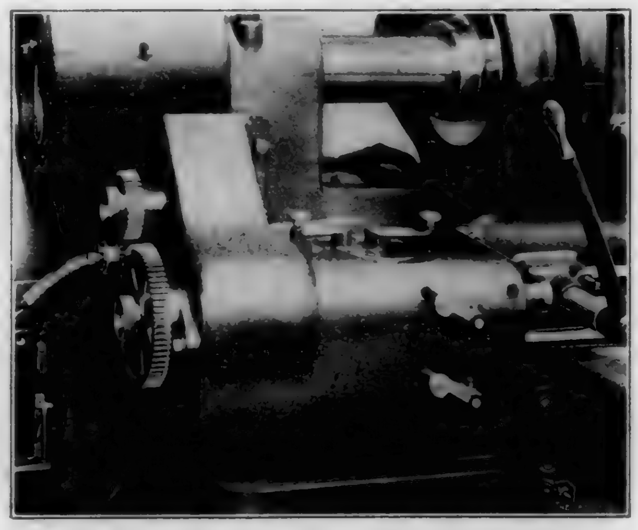


FIG. 5—FEED BOX FOR TURRET AND CARRIAGE.

ABLE SMOKE JACKS.—We have smoke jacks with throats about 12 to 14 ft. long, lengthwise of the pits, so that, no matter what position the locomotive is in, there is an open jack above it, so we have very little trouble from smoke under any conditions.—*A. R. Raymer, before Western Railway Club.*

CLASSIFICATION OF LOCOMOTIVE REPAIRS.

CANADIAN PACIFIC RAILWAY.

On page 141 of this journal for April of last year, appeared a discussion of locomotive repair records, but at the time the name of the road concerned was not given. It may, however, now be stated that Mr. H. H. Vaughan, then of the Lake Shore & Michigan Southern Railway, was the originator of that system, which has since been developed by him, as superintendent of motive power of the Canadian Pacific, into the new system which he has put into effect on the latter road and describes as follows:

The classification of repairs in general use employs very commonly 3 to 5 numbers, which are frequently accompanied by suffix letters indicating whether an engine has had heavy, medium or light machinery repairs, whether tubes have been reset or not and the nature of the firebox work performed. In order to clearly describe the various combinations that may exist, this system becomes complicated; and in the scheme previously referred to an attempt was made to simplify it by dividing the machinery repairs into two classes, viz.: Class 1 and Class 2 machinery repairs, No. 1 indicating engines receiving general overhauling, and No. 2 indicating a light overhauling but heavier repairs than those commonly termed running repairs, and employing a suffix letter to show whether tubes were reset or not. In the system now described this classification has been amplified and made more distinct and serviceable, and while slightly more complicated, is, when once understood, perfectly clear and easy to employ.

The same idea is carried out of separating running repairs, which are strictly maintenance charges and which constitute work which must be performed on an engine from time to time to keep it in normal condition, from shop repairs, which either constitute a general overhauling of the engine, changing it from a rundown and unworkable condition into a repaired and, so far as its operation is concerned, practically a new engine, or repairs which are done to it between its general overhaulings and enable it to keep the road for a longer time than would be the case had it only received running repairs. A distinction between shop and running repairs is a difficult one and was not distinctly settled in the Lake Shore report. On the Canadian Pacific a distinction has been made by calling repairs which cost less than $100 for labor "Running Repairs," and those on which the amount of labor exceeds $100 "Shop Repairs." Additional classes of repairs, such as "Wreck" and "Defect," are also introduced. Wreck repairs for the reason that they are not chargeable to the maintenance of locomotive account under the Interstate Commerce Commission classification, and defect repairs in order to separate from the maintenance account that class of repairs and expenditures such as those due to broken piston rods, broken spring hangers, etc., which, while chargeable to maintenance of locomotives are not repairs that it is fair to hold the division officers responsible for. Running repairs are evidently an expenditure that is every month properly proportional to the locomotive mileage made during that month, whereas the cost of shop repairs in any month does not depend upon the mileage run, but on the amount of work put on the power in the shops to improve its condition, or, as it may be termed, to the mileage shopped.

Over a considerable period it would be satisfactory to regard the mileage shopped as an aggregate of the mileage made since last general overhauling by each engine receiving general overhauling during that period. In the long run, if the condition of power is maintained at a normal level, the mileage shopped must be equal to the mileage run. If, however, the condition of power is allowed to deteriorate, it would not be as great, and on the contrary, if the condition were built up it would be larger. It is important, therefore, to know in each month, the mileage shopped, and this is preferably based on the engines receiving a general overhauling of machinery; it is also necessary to know the number of engines receiving complete sets of tubes in order to determine the condition of the engines as regards tube mileage. In the classification of repairs described, these overhaulings are very closely determined, and additional information is easily noted by means of

FORM 1.

CANADIAN PACIFIC RAILWAY COMPANY.

Report of engines out of service over twenty-four hours for running repairs during period ending 190

Station.	A Engine Number.	B Class of Repairs.	C Taken Out of Service.	D Taken into Shop.	E Expected Out.	F Turned Out.	G Days in Shop.	H Nature of Repairs.

(This form has 30 blank lines under these headings.) Signature.........................

Running repairs are those estimated not to exceed $100 for labor.
Wreck and defect repairs are to be shown on this form when cost is estimated not to exceed $100 for labor, and when not accompanied by shop repairs.
Under class of repairs show whether running, wreck or defect.
Letters to be used to wire information when so instructed.
This form to be sent in on 7th, 14th, 21st and end of each month to master mechanic.

FORM 2.

CANADIAN PACIFIC RAILWAY COMPANY.

Report of engines out of service over twenty-four hours for shop repairs during period ending 190

Station.	A Engine Number.	B Shop Repairs. Mach.	Tubes.	Firebox.	C Wreck or Defect.	D Taken Out of Service.	E Taken Into Shop.	F Expected Out.	G Turned Out.	H Days in Shop.	J Remarks.

(This form has 30 blank lines under these headings.) Signature.........................

Shop repairs are those estimated to exceed $100 for labor.
Wreck and defect repairs are to be shown on this form when costis estimated to exceed $100 for labor, or when accompanied by shop repairs.
Under remarks give nature of wreck or defect repairs.
Letters to be used to wire information when so instructed.
This form to be sent in on 7th, 14th, 21st and end of each month to master mechanic.

FORM 3.

CANADIAN PACIFIC RAILWAY COMPANY.

Summary of engines out of service over twenty-four hours for all repairs during period ending 190

Station.	Number of Shop Repairs. Machinery. No. 1.	No. 2.	No. 3.	Tubes. No. 1.	No. 2.	Fire Box Sheets.	Average Days in Shop.	Mileage. Machinery.	Tubes.	Number with Wreck.	Defect.	Running.	Total Days Out of Service for Running Repairs.
(This form has 30 blank lines here.)													
Total													

the forms illustrated, even for a considerable number of engines.

In order to avoid complication, different forms are used for reporting engines out of service for shop and running repairs, and wreck and defect repairs are reported on the same blank as running repairs where of about the same value, viz., $100 for labor. This distinction is made on the estimate of the locomotive foreman, as it is evidently not very important should an occasional error be made, and it is easy to detect any mistake in this matter from the monthly accounts. Basing the dividing line on the estimate, the storekeeper and the accountant knows the moment an engine is in the shop whether it is held up for shop or running repairs and can arrange his accounts accordingly. It will be noted in making the summary, which can be made weekly or monthly, no attention is paid to whether an engine receiving Class 1 machinery is the same engine that received Class 1 tubes or not, as all that it is necessary to know is the number of general or partial overhaulings of machinery, complete or partial sets of tubes and firebox sheets that have been turned out during the month.

It will be noted in this classification, a distinction is made between engines receiving light repairs with tire turning and those receiving light repairs without tire turning. A classification is also made for engines receiving partial sets of tubes, and it will be seen that by the means of three figures a very close idea can be given of an engine receiving any kind of shop repairs and whatever way they were combined. Form No. 1 is for running repairs and Form No. 2 for shop repairs. The Form No. 3 also gives a rough statement of the output of each shop during the month, and the total gives the output of all shops on the road. This form can be prepared within a few days after the end of each month and is certainly of the greatest use in watching results obtained from time to time.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

PARIS.

The visit of the editor of this journal to the motive power chief of the Northern Railway of France should interest the reader. It touches the methods of handling locomotives and shows why these people have such efficient service. It shows how this road operates locomotives on from 17 to 19 lbs. of water per h.p. per hour. This road is prominently mentioned as more time was spent upon it than upon the others and because it is representative of French practice.

Mr. du Bousquet speaks no English, and my French, learned at school, is too out of date for use now-a-days. I had several letters of introduction and was personally introduced by Mr. Tachard, of the Societe Alsacienne de Constructions Mechaniques, who proved a most efficient and courteous interpreter on several occasions. When told of my general interest in four-cylinder compounds and of the very large amount of information wanted, Mr. du Bousquet said with open-handed gesture: "We shall be pleased to tell and show anything we have and to furnish anything we can get concerning our work." He at once arranged a trip on locomotive No. 2645, which had been in service continuously for two years since leaving the builder's works at Belfort and had made 186,942 kilometers or 116,000 miles. This engine was selected in order to give an idea of the work done under unfavorable circumstances. The visitor was then taken in hand by Mr. Roderigue, chief assistant to Mr. du Bousquet, and by Mr. Koechlin, chief draftsman. These gentlemen showed very great familiarity with all of the details touched upon in the conversation and with them a profitable time was spent over the drawings and records of the engines hauling the fast trains between Paris and Calais. This road has most active competition for English-Continental business and this has had the effect of making it one of the most progressive of French roads.

Engine No. 2645 is an Atlantic type. It was put on a morning train specially for my benefit; the return was also arranged so that the entire trip of 370 miles could be made on one engine, and furthermore one of the best engineers on the road was in charge. These people have nothing sufficiently severe to say of pooling. On brass plates at the sides of the cab the names of the engine crew appeared. Engineer Huart, Fireman Vassal. The men take great interest in their work and the fact that their names are closely associated with the engine leads them to assume responsibilities for its condition which are not seen under the pooling system. On the trip to Calais the sander gave trouble; on the return journey it worked perfectly. The sand was damp and as the rail was very bad the engineer took no chances but saw to it personally and had the sand taken out, the pipes cleaned and dried and dry sand supplied. This is a small item, perhaps, but it illustrates a point that seems important. The engineer remained with the engine during his two hours "lay-over" to make sure that everything was done right. He watched the fire cleaning and everything that was done. He also personally inspected the machinery. His premium was at stake and he wanted the cash which he might earn by being on time and by saving fuel. This premium matter will be referred to again as it plays an important part in locomotive performance in France. When the engine was known to be properly cared for and the sander fixed the engineer had ten minutes left for his dinner. Contrast this with the indifference of our engineers at home. On the arrival of every passenger train at Calais the roundhouse foreman meets the engineer at his engine to ascertain the condition of the engine and the amount of work required before the return run. Contrast this also with our practice. Our roundhouse foremen do not have time to do such things.

In spite of the fact that we did not speak the same language, the engineer and the writer were busy all the way talking in signs and grimaces. The engine was also busy, and the fireman. Leaving Paris at 9.45 a.m., the train was scheduled to arrive at Calais, 185 miles, in 3 hours and 20 minutes, with one stop at Amiens. There were actually three stops and two slow-downs for bridge repairs, and yet the speed from start to finish was 56 miles per hour, with a train weighing 216 tons. The run did not tax the engine in the least and the gauge glass was only twice less than half full. This is a very light engine for such work and I am told that trains of 350 to 390 tons are regularly handled on this schedule. I never saw an engine so skillfully handled and this is most interesting because of the fact that the engineer had the throttle, the variable exhaust and the independent valve gears for high and low pressure cylinders, which he could adjust at will to meet changing conditions of track and grades. He did not change them continually, but when running on a level he would indicate with his hand that we were approaching a grade and with a piece of chalk would indicate its rate and length. Before reaching the grade the ratio of expansion would be changed by the reversing wheel and except on the steepest grades the speed was apparently very nearly constant. The near approach to constant speed was necessary because of a statutory limit of maximum speed to 75 miles per hour. This fact makes these French runs specially interesting because there are no bursts of speed or spurts. Business began on leaving the terminal and it ended at the other terminal. On down grades the throttle was generally closed. Most of the way with this train the cutoffs were 40 per cent. in the high pressure and 60 per cent. in the low pressure cylinder. Up hill these were changed sometimes to 48-60 and sometimes to 48-62 and the throttle was wide open. On reaching level track again the throttle was partly closed and the ratio made 40-60. The engineer kept close watch of the gauge showing the receiver pressure and kept it usually at about 3 kilograms. But for my misfortune in not understanding the language this very

intelligent man would have made clear his reasons for everything he did. I can only say that having the facilities at his command he adjusted this compound to its work and was in position to get out of it all that the boiler could supply. In order to show the effect of the variable exhaust he purposely let the boiler pressure fall to about 200 lbs. and then turned up the cone in the exhaust nozzle by the hand wheel in the cab. In less than a minute the safety valves were blowing at 213 lbs. while the engine was working hard. This, however, slowed the engine down perceptibly until the nozzle was opened again to its running position, which was nearly wide open. The engineer shrugged his shoulders, pointed to the coal pile and very quickly opened the nozzle. Whether all of the engineers do so or not I am unable to say, but this one certainly used the nozzle, the throttle and the reversing wheel most effectively. I am told that the Northern Railway has in its employ a "compound trainer" to whose efforts among the engineers the fine character of firing and running is due.

Mentioning the variable exhaust reminds me that Mr. Koechlin showed me the detail drawings of this device. The main casting of the exhaust pipe terminates in a conical opening of 200 sq. millimeters area. Inside this is a hollow truncated cone which may be raised into this nozzle or lowered away from it into the large cavity of the pipe below. When lowered it does not interfere with the opening and when raised into the top of the pipe the inside opening of the movable cone becomes the exhaust area, which is 99 sq. millimeters. The exhaust was soft and it did not "cut" the fire except when the nozzle was made smaller purposely.

It should be stated that there is no anxiety about the lubrication of these engines. The driving boxes are oiled from the cab, while the valves and cylinders are supplied by a positive lubricating pump driven by a connection to the valve motion. This pump is placed on the running board on the left (or engineer's side), where it does its work very effectively. These pumps are being generally introduced on the Continent and I saw very few displacement lubricators. From the pump small copper pipes lead to the valves, to the cylinders and in some cases to the piston rods.

These engines have Serve tubes and by watching the vacuum gauge I could not see the slightest change in the vacuum in the smoke box when the fire door was open. The tubes were all tight, which must be attributed to the long brick arch.

We would consider the firing rather heavy. It varied from 3 to 7 scoops of coal at 4 to 6 minute intervals. Most of the coal was put rather close to the door with an occasional scoopful into the front corners. Very little of it was thrown under the arch. At intervals of about 20 minutes the fire was raked forward with a double hook. When working steam there was no smoke worth mentioning and in returning at night there were but very few sparks. The coal was coked at the back end of the firebox and was worked forward by the hook, aided by the sharp slope of the grates. The grates were of the fixed type and could not be rocked. At the front end a clinker drop afforded an opening for cleaning the fire.

These engines are supplied with briquettes in the proportion of 14 per cent. to 86 per cent. of coal. They measure 7½ by 11½ by 5½ ins. and 8 of them were kept on the deck in front of the firedoor. Several times on the run these were fired when running down grade to get the benefit of the best fuel when taking an up grade beyond. It was evident throughout the run that the engineer and firemen were personally interested in the pile of coal on the tender and they used it as if it was their own. This was a new experience for me. It did not seem to be done for the benefit of the newspaper man, but had the appearance of usual practice. I also noted that the fireman watched the engineer very closely and usually waited for a motion of his hand before putting in a fire or using the hook.

The game of running this locomotive was skilfully played. This work impressed the writer as would a violin in the hands of an artist. This engineer had more strings to his instrument than those handling other types of locomotives. He did not appear to be of higher grade of intelligence than the locomotive runners of other countries, but he had a good machine, was well trained and was truly interested in his work.

Returning from Calais to Paris this engine was put on a special train chartered to haul the crews of a couple of war vessels bought in Italy by the Japanese government and destined for use in the war with Russia. The crews appeared to be very Irish. They were certainly very drunk and proved to be a heavy load. The train weighed but 178 tons, but the coal was bad and signal stops were frequent and vexatious. I was glad to have the opportunity to see the engine get out of its difficulties. In spite of 6 stops and 15 minutes of dead time, the run of 185 miles was made at 50 miles per hour from start to finish. Once on the run, while both injectors were feeding, one of them broke and before it was started going again the steam ran down to 12 kilograms. The fireman did his best, but could not get it back. The engineer took the scoop and in about fifteen minutes had the full boiler pressure of 16 kilograms again by his firing alone. I raised my hat to him and pointed to the gauge. He chuckled, went back to his side of the cab again and smiled all the way back to Paris.

These cabs are of little use. The wind blows through them as through a Dakota barn and makes them supremely uncomfortable. I could not light my cigar even down among the oil cans until the engineer came to my aid with a bit of waste which he had touched against the inside of the firedoor. Ugh! I cannot understand why these people do not put respectable cabs on their engines. It seems that the enginemen themselves object to American cabs, but it is incomprehensible that they do not wish to be better protected, for often the weather is cold, as it was that day.

The running skill of this engineer tells of years of definite and conscientious effort on the part of the whole department of which Mr. du Bousquet is the head. It tells of a system of operating the department which has been years in growing. It offers most favorable evidence of the value of cash premiums and constitutes practice which we may study with advantage. Above all other things it shows that the machinery is but a part of the whole and that the training, the encouragement and the interest of the men operating it is an all important part.

G. M. B.

(To be continued.)

THE RELATIVE STEAM ECONOMY OF BALDWIN AND DE GLEHN BALANCED COMPOUND LOCOMOTIVES.

To the Editor:

In the course of the interesting record of road tests of the Burlington & Missouri River Railroad, 4—4—2 type, Baldwin balanced compound locomotive No. 2700, which appears on page 460 of the current issue of the AMERICAN ENGINEER, the average normal water-rate of the engine is given as 22.86 lbs. per indicated h.p. per hour.

This is certainly a most admirable performance, which reflects great credit upon the designers and builders of the locomotive, and also upon the motive power officials responsible for its maintenance and operation.

For the purpose of comparing this water-rate with that of recent examples of the Du Bousquet-deGlehn type of compound locomotive on the Paris-Orleans Railway, the following remarks made by M. Edouard Sauvage, chief consulting engineer Western Railway of France, at the April, 1904, meeting of the Institution of Mechanical Engineers, are of special interest:

M. Sauvage said that "a long series of experiments, made on the Paris-Orleans line with trains of different weights, had shown a steam-consumption per h.p. per hour never differing much from 23 lbs. The h.p. was neither the indicated h.p. nor the power calculated from the draw-bar pull; but it was the h.p. exerted by the wheel on the rail, and that power was calculated from the results of numerous experiments made with the use of the dynamometer car. The Paris-Orleans Railway engineers were confident that they could calculate carefully and closely the effective pull exerted by the wheel on the rail, and that was what they called an effective h.p. They found that with trains of 220 tons (2,240 lbs.) the average steam consumption was 23 lbs. With trains of 260 tons it was 22.6 lbs. With heavy trains of 352 tons it was 23.7

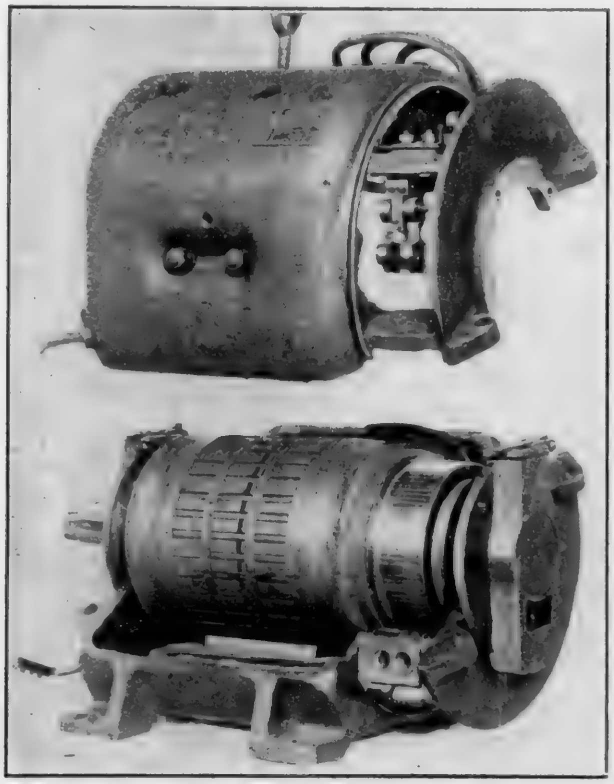
lbs. There was, therefore, hardly any difference in the water consumption per effective h.p. per hour in all these different cases. When one came to practical work it would be seen that heavy train working was more economical than light train working. It was most definitely so, because the weight of the engine was a smaller proportion of the weight of the whole train." (Proceedings Inst. Mech. Engrs., 1904, page 451.)

Since the steam consumption of the Baldwin locomotive is based upon the indicated h.p., while that of the Paris-Orleans engines is stated in terms of the effective h.p. at the periphery of the driving wheels, it is obviously impossible to make an accurate comparison between the economy of the two designs of locomotives; but it is nevertheless apparent that although the mean water-rate of the American engine is higher than that of its formidable French rivals, the smallness of the disparity demonstrates that the former is an exceedingly economical locomotive.

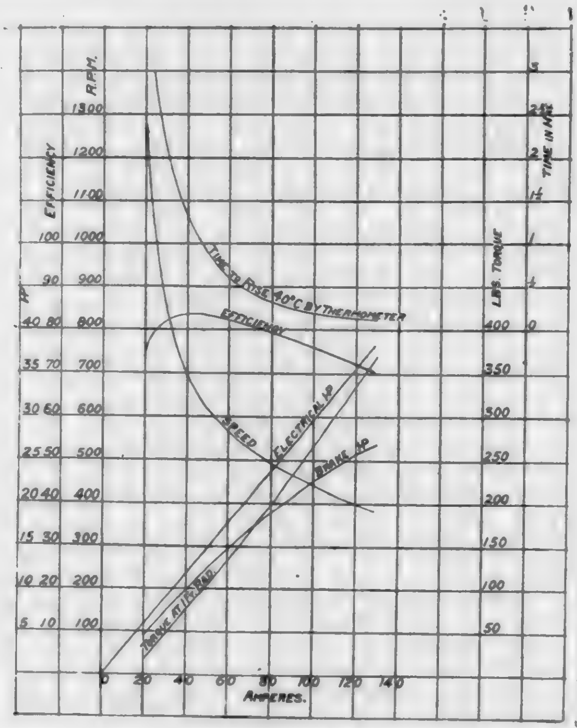
EDWARD L. COSTER,
25 Broad street, New York. Assoc. Am. Soc. M. E.
December 6, 1904.

SATISFACTORY SUBURBAN SERVICE.—In a paper read before the International Railway Congress, Mr. A. W. Sullivan states that the cars designed by him for the Chicago suburban service of the Illinois Central Railroad have shown the possibility of discharging 100 passengers in 4 seconds at the terminal station, and that stops at intermediate stations, where many passengers enter and leave the cars, are reduced from 6 to 8 seconds. These cars were illustrated in this journal in 1903, and have met the expectations of the designers in every particular.

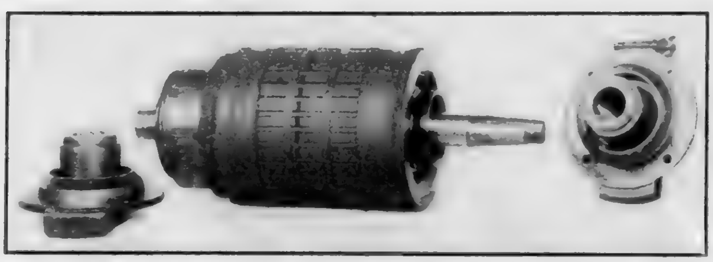
LONG LOCOMOTIVE RUN.—The Great Central Railway (England) ran a special train, October 28, making the entire run of 300 miles between Manchester and Plymouth, with one engine. The same engine immediately made the return journey. This had never been attempted before in Great Britain.



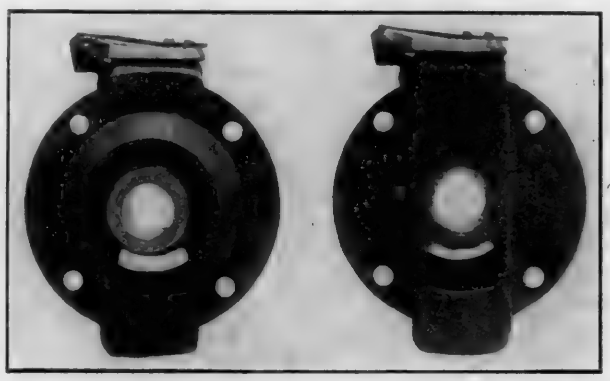
WESTINGHOUSE TYPE K CRANE MOTOR WITH UPPER FIELD RAISED.



EFFICIENCY CURVE—WESTINGHOUSE NO. 6 TYPE K CRANE MOTOR.



ARMATURE AND BEARING HOUSINGS—WESTINGHOUSE TYPE K CRANE MOTOR.



BEARINGS AND BEARING HOUSINGS—WESTINGHOUSE TYPE K CRANE MOTOR.

NEW WESTINGHOUSE CRANE MOTOR.

The service required of an electric crane is very exacting, and it is important that the motor be selected with the greatest care, as its failure may seriously incommode the plant in which it is used and cause heavy losses, due to restricted output. Westinghouse type K motors are designed for the operation of cranes, hoists and similar apparatus, and for intermittent service, in which heavy starting torques and wide speed variation are required. They are strong and compact, convenient to install, adaptable to every practical form of mounting, and are reliable, economical and powerful in operation.

The frames are of the wholly enclosed form, to guard against dirt and moisture, but are so designed that the working parts may be exposed for inspection or adjustment without dismantling. These motors have four inwardly projecting poles,

each of which is magnetized by a separate field coil, which arrangement is claimed to be very advantageous. They are series wound, and are designed for operation on direct current circuits of 220 and 500 volts. Since the current passes successively through the armature and field winding, the torque of such a motor increases nearly as the square of the current up to the point of saturation of the iron. For this reason the series motor is particularly well suited to the starting and acceleration of heavy loads. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range.

The motor frames are of cast steel, except in the three smallest sizes, and are extremely compact. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of 34 deg. with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole piece and field coils, or to remove the armature. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush holders. The opening around the commutator is entirely closed by a 3-32-in. sheet steel band, fastened by thumb screws, an arrangement which permits access to the commutator and brush holders at all points. The four pole pieces are built up of soft steel punchings, riveted together between wrought iron end plates, and are secured to the frame by bolts which pass well into the punchings, but leave the pole face smooth and unbroken. The coils of the larger motors are of copper strap, and the terminals are insulated with asbestos ribbons. They are fitted to the pole pieces, protected at the ends by oiled duck, and held in place by the spreading tips of the pole pieces. Large journal bearings are provided, which consist of shells lined with bronze or babbitt, and mounted in housings which may be removed without separating the motor frame.

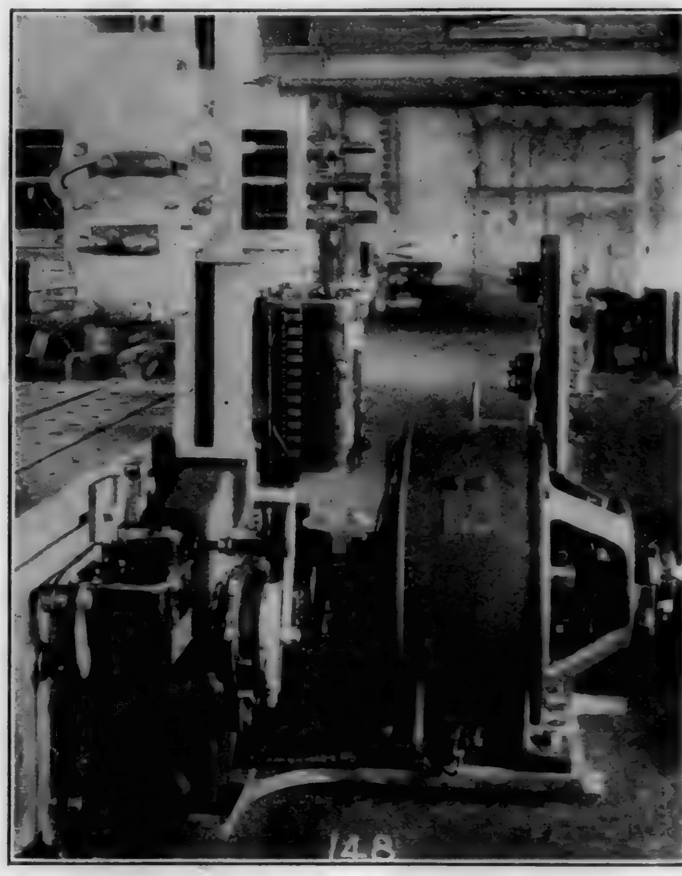
The armature core is built up of soft steel punchings of high permeability, carefully annealed by a special process. The pinion end is provided with a bell-shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections.

The commutator is built up of bars of hard drawn copper, insulated by prepared mica, and mounted on the armature spider. The brush holders are of the sliding type, and possess many features of peculiar merit. Adjustment can be made to compensate for wear of the commutator. With all but the two smaller sizes a shunt is connected to the tip of the spring, extended back over the spring and securely fastened to the brush holder, thus relieving the spring of the duty of carrying current, insuring good contact, low operating temperature and a permanent and even tension. With every carbon brush ⅝ in. or more in thickness, an additional sheet is provided connecting the carbon itself to the carbon holder, improving the contact between carbon and holder, and preventing that pitting of the brush which is so annoying and troublesome, besides offering a further protection to the temper of the spring.

IMPROVED MOTOR DRIVE FOR PLANERS.

Among the many improvements which we have recorded in planer drives during the past few years, none have been so radical as that of connecting an electric motor direct to the cross-shaft of the planer, and reversing the motor at each end of the stroke. It seems almost incredible that the armature of a high-speed motor can be stopped and reversed without a considerable loss of time; but, as a matter of fact, it stops, reverses, and accelerates so quickly, that the planer platen seems to travel at a constant speed to the end of the stroke, stop quickly, and then accelerate so fast on the return stroke that it is at full speed before it has moved more than 3 or 4 ins. Not only this, but if one of the motor commutator bars is marked, it will be seen to stop at exactly the same place at each stroke. The device does not require a special type of motor, and it can be arranged to provide a number of different cutting speeds, with a constant speed for the return stroke.

The advantages of such a drive are that the belts, pulleys and shifting mechanism can be done away with, thus greatly simplifying the drive; the speed of the platen on the cutting stroke, which is ordinarily limited, because of the belts can be increased, and the advantages of the high-speed tool steels can be more fully realized. The Electric Controller & Supply Company, of Cleveland, have had this drive running successfully for some time on a 36-in. and a 96-in. planer at the works of Wellman-Seaver-Morgan Company in Cleveland, and also on



APPLICATION OF IMPROVED MOTOR DRIVE TO PLANER—ELECTRIC CONTROLLER & SUPPLY COMPANY.

a 36-in. Pond planer, which was exhibited at the St. Louis Exposition.

The photograph shows the arrangement of the electrical apparatus. The motion of the motor is reversed by means of a magnetically operated controller, carried on the switchboard shown just beyond the motor. The operation of this controller is such that a platen will reverse and accelerate just as rapidly as is consistent with the power of the motor. The maximum current which can flow to the motor is absolutely limited, so that there is no sparking or undue mechanical straining at the instant of reversal. On future installations this controller will be moved closer to the planer bed, where it will be out of the way of passing workmen. In addition to the magnetic switch controller, the equipment consists of a reversing switch, mounted on the bed of the planer, and which may be operated either by the adjustable dogs on the platen or by a lever. This lever is the only apparatus necessary to start or stop the planer, and can be thrown either on or off as quickly as desired, without danger of injuring either the motor or machine. The field rheostat, or operating controller, on the side of the housing is used for varying the speed of the cutting stroke of the platen. This controller is provided with a notched dial, which plainly shows the cutting speed for each step.

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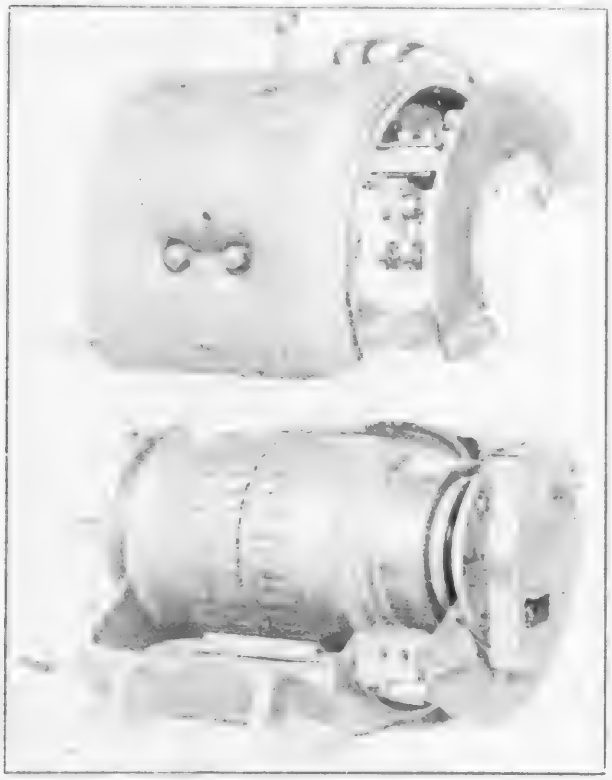
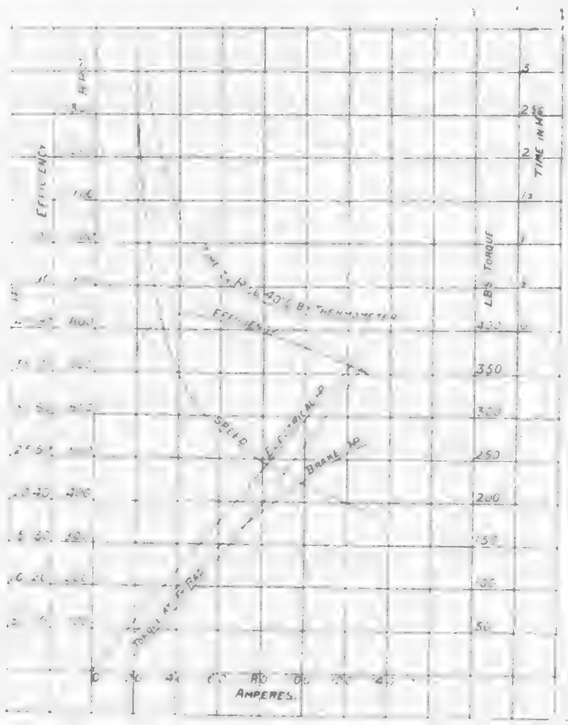
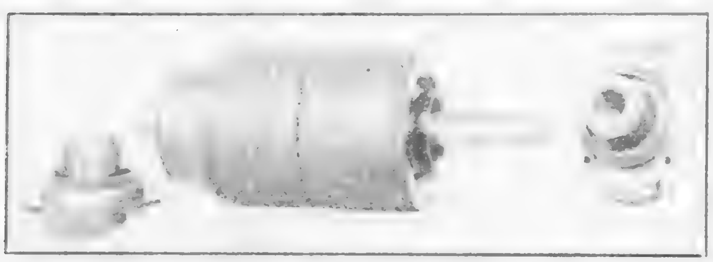


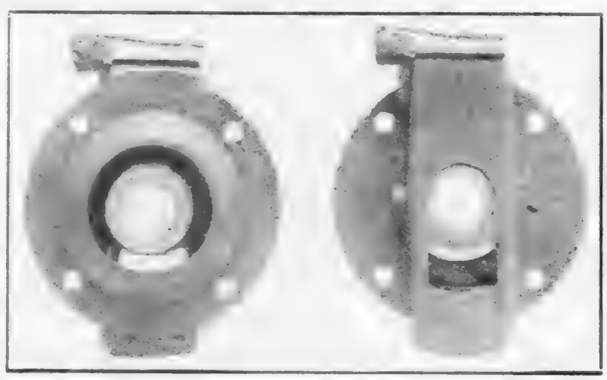
WESTINGHOUSE [illegible] E MOTOR WITH UPPER FIELD RAISED.



EFFICIENCY CURVE—WESTINGHOUSE NO. 6 TYPE K CRANE MOTOR.



ARMATURE [illegible] WESTINGHOUSE TYPE K CRANE [illegible]



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The frames are of the wholly enclosed form, to guard against dirt and moisture, but are so designed that the working parts may be exposed for inspection or adjustment without dismantling. These motors have four inwardly projecting poles.

each of which is magnetized by a separate field coil, which arrangement is claimed to be very advantageous. They are series wound, and are designed for operation on direct current circuits of 220 and 500 volts. Since the current passes successively through the armature and field winding, the torque of such a motor increases nearly as the square of the current up to the point of saturation of the iron. For this reason the series motor is particularly well suited to the starting and acceleration of heavy loads. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range.

The motor frames are of cast steel, except in the three smallest sizes, and are extremely compact. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of 34 deg. with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole piece and field coils, or to remove the armature. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush holders. The opening around the commutator is entirely closed by a 3-32-in. sheet steel band, fastened by thumb screws, an arrangement which permits access to the commutator and brush holders at all points. The four pole pieces are built up of soft steel punchings, riveted together between wrought iron end plates, and are secured to the frame by bolts which pass well into the punchings, but leave the pole face smooth and unbroken. The coils of the larger motors are of copper strap, and the terminals are insulated with asbestos ribbons. They are fitted to the pole pieces, protected at the ends by oiled duck, and held in place by the spreading tips of the pole pieces. Large journal bearings are provided, which consist of shells lined with bronze or babbitt, and mounted in housings which may be removed without separating the motor frame.

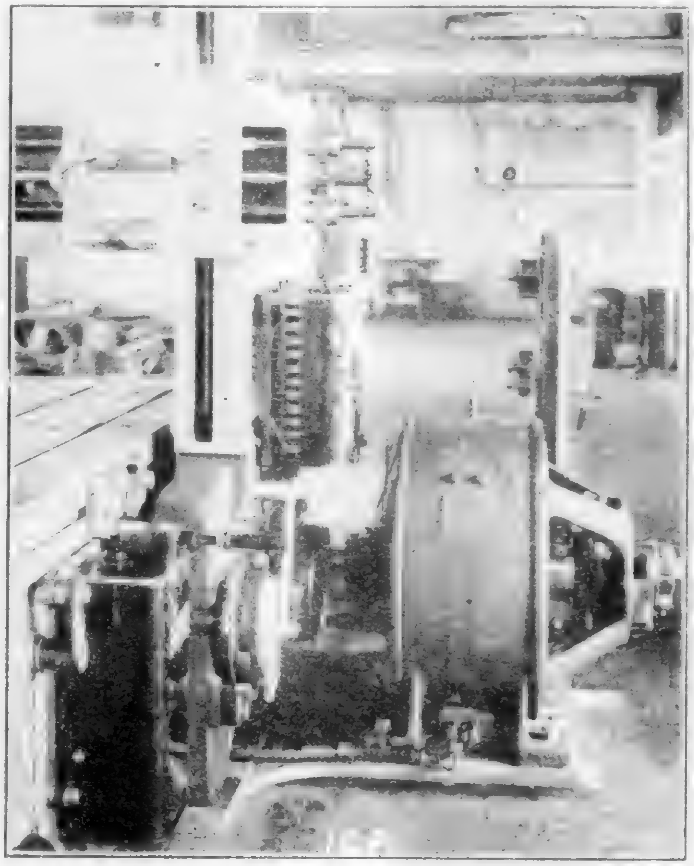
The armature core is built up of soft steel punchings of high permeability, carefully annealed by a special process. The pinion end is provided with a bell-shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections.

The commutator is built up of bars of hard drawn copper, insulated by prepared mica, and mounted on the armature spider. The brush holders are of the sliding type, and possess many features of peculiar merit. Adjustment can be made to compensate for wear of the commutator. With all but the two smaller sizes a shunt is connected to the tip of the spring, extended back over the spring and securely fastened to the brush holder, thus relieving the spring of the duty of carrying current, insuring good contact, low operating temperature and a permanent and even tension. With every carbon brush ½ in. or more in thickness, an additional sheet is provided connecting the carbon itself to the carbon holder, improving the contact between carbon and holder, and preventing that pitting of the brush which is so annoying and troublesome, besides offering a further protection to the temper of the spring.

IMPROVED MOTOR DRIVE FOR PLANERS.

Among the many improvements which we have recorded in planer drives during the past few years, none have been so radical as that of connecting an electric motor direct to the cross-shaft of the planer, and reversing the motor at each end of the stroke. It seems almost incredible that the armature of a high-speed motor can be stopped and reversed without considerable loss of time; but, as a matter of fact, it stops, reverses, and accelerates so quickly, that the planer platen seems to travel at a constant speed to the end of the stroke, stop quickly, and then accelerate so fast on the return stroke that it is at full speed before it has moved more than 3 or 4 ins. Not only this, but if one of the motor commutator bars is marked, it will be seen to stop at exactly the same place at each stroke. The device does not require a special type of motor, and it can be arranged to provide a number of different cutting speeds, with a constant speed for the return stroke.

The advantages of such a drive are that the belts, pulleys and shifting mechanism can be done away with, thus greatly simplifying the drive; the speed of the platen on the cutting stroke, which is ordinarily limited, because of the belts can be increased, and the advantages of the high-speed tool steels can be more fully realized. The Electric Controller & Supply Company, of Cleveland, have had this drive running successfully for some time on a 36-in. and a 96-in. planer at the works of Wellman-Seaver-Morgan Company in Cleveland, and also on



APPLICATION OF IMPROVED MOTOR DRIVE TO PLANER.—ELECTRIC CONTROLLER & SUPPLY COMPANY.

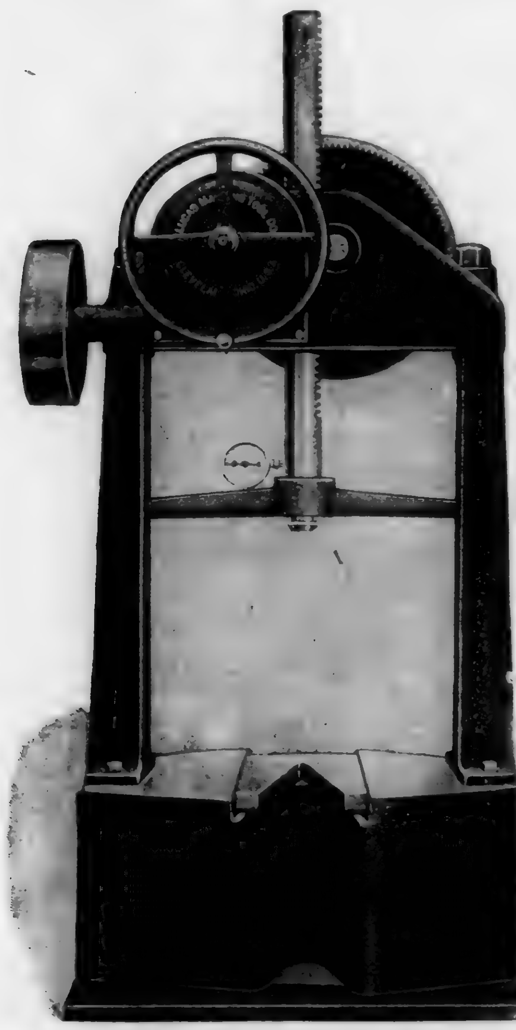
a 36-in. Pond planer, which was exhibited at the St. Louis Exposition.

The photograph shows the arrangement of the electrical apparatus. The motion of the motor is reversed by means of a magnetically operated controller, carried on the switchboard shown just beyond the motor. The operation of this controller is such that a platen will reverse and accelerate just as rapidly as is consistent with the power of the motor. The maximum current which can flow to the motor is absolutely limited, so that there is no sparking or undue mechanical straining at the instant of reversal. On future installations this controller will be moved closer to the planer bed, where it will be out of the way of passing workmen. In addition to the magnetic switch controller, the equipment consists of a reversing switch, mounted on the bed of the planer, and which may be operated either by the adjustable dogs on the platen or by a lever. This lever is the only apparatus necessary to start or stop the planer, and can be thrown either on or off as quickly as desired, without danger of injuring either the motor or machine. The field rheostat, or operating controller, on the side of the housing is used for varying the speed of the cutting stroke of the platen. This controller is provided with a notched dial, which plainly shows the cutting speed for each step.

POWER FORCING PRESS.

The simple and convenient power forcing press illustrated in the photograph is designed to dó rapidly all kinds of work requiring pressure, much of which has heretofore been done by sledges or slow-moving hand presses.

The uses of such a press are practically universal and include such work as forcing arbors, bushings and pins in or out of holes, straightening shafting, forming, broaching, all kinds of testing work, and will be found especially convenient in railroad shops for forcing in or out rod and driving box brasses. Pressure is applied by the large hand wheel, which quickly raises or lowers the ram until it meets with resistance, when power is automatically applied, the pressure being proportionate to the turning force applied by the operator. As soon as this force is released the action of the press



POWER FORCING PRESS—LUCAS MACHINE TOOL COMPANY.

stops, so that in case anything goes wrong pressure ceases instantly by simply letting go of the wheel. The belt does the work quickly without any effort on the part of the operator other than to turn the wheel sufficiently hard to keep a friction applied, which results in tons pressure on the ram for pounds pulled on the wheel.

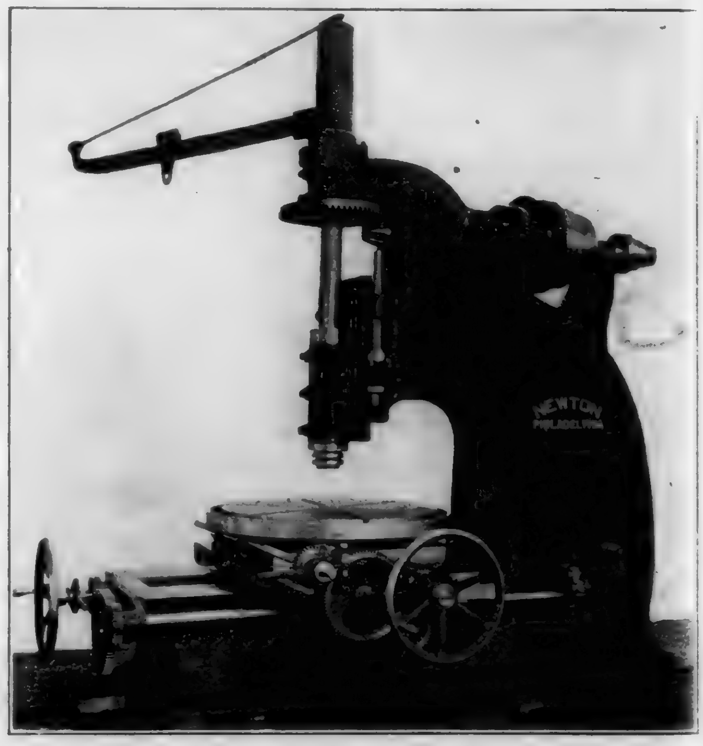
The gauge shows the number of tons pressure on the ram, so that the press is in complete and intelligent control of the operator, and all by means of the hand wheel. No shifting of belts or clutches is required; there are no pumps, packing or valves to keep in order and there is nothing to freeze.

These presses are made by the Lucas Machine Tool Company of Cleveland in two standard sizes of 15 and 30 tons capacity. Presses adapted for higher pressures and in horizontal or special forms may be made to order.

VERTICAL MILLING MACHINE.

The photograph illustrates a large vertical milling machin recently installed in the Havelock shops of the Burlington (Missouri River Railroad. Although it has been in use bu a short time, it has greatly reduced the cost of a number o operations which were formerly done on slotting machines These include the machining of dome saddles, side rod ends mud rings, cab brackets, equalizers, front frames and braces cross braces, cinder hopper bases, reverse lever quadrants links and cast-iron pedestal jaws for engine and tender trucks

The machine is very heavy and powerful, and was designe for the use of high-speed tool steels. The spindle, which i 5 ins. in diameter, is driven by the three-step cone and th bevel gears; the cone is back geared, thus furnishing si changes of speed. The circular table is 48 ins. in diamete over the tee slots and 54 ins. over all, and has a cross adjust ment of 36 ins. The table has five changes of automatic fee in either a rotary, cross or longitudinal direction, each mo tion being controlled by clutches conveniently placed; th



VERTICAL MILLING MACHINE—NEWTON MACHINE TOOL WORKS.

reverse motion is imparted by the tumble gears shown in the illustration. The distance from the top of the table to the under side of the throat is 20 ins., and from the center of the spindle to the frame is 28 ins. The auxiliary self-contained crane is used for supporting the end of long overhanging work. The machine was made by the Newton Machine Tool Works of Philadelphia, and they are now arranging to fit the spindles of this type of machine with vertical automatic feed.

Five and One-Half Months Continuous Run.—The 600-h.p. Westinghouse steam turbine generating unit which supplied current for light and power throughout the Westinghouse exhibits at the St. Louis Exposition, was shut down on December 2 after a continuous run of five and one-half months, or 3,962 hours. The remarkable feature of the run was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8.30 o'clock in the morning to 10.30 o'clock in the evening, the load carried throughout the exposition varied from 25 per cent. underload to 25 per cent. overload. The total number of revolutions almost touched the billion mark—855,792,000. It was found to be in perfect condition, with no signs of wear, the bearings still retaining the tool marks as they had come from the shop.

IMPROVED VALVES.

After 50 years of practical experience in the manufacture of steam appliances, the Crane Company, of Chicago, has developed a number of improvement of importance to those having to do with locomotives and the application of steam for power and heating. This company has brought out improved globe and angle valves with renewable seats and discs. They are suitable for working pressure up to 250 lbs. per sq. in., and are tested to pressures as high as 700 lbs. The renewable parts are made of hard composition, specially developed by these manufacturers for severe service. Fig. 1 shows the construction of a straight valve. By unscrewing the nut on the bottom of the valve all parts are accessible and removable from the top, making it convenient to substitute a new seat

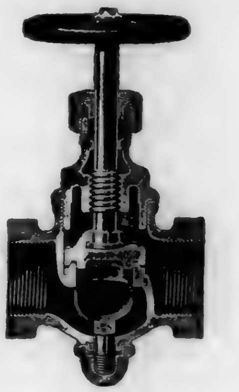


FIG. 1.

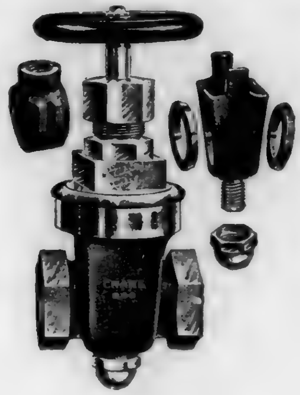


FIG. 2.

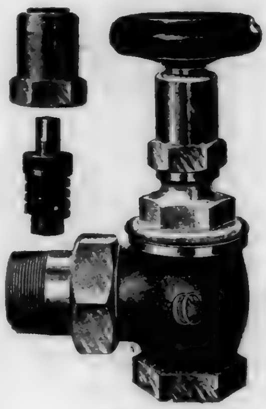


FIG. 3.

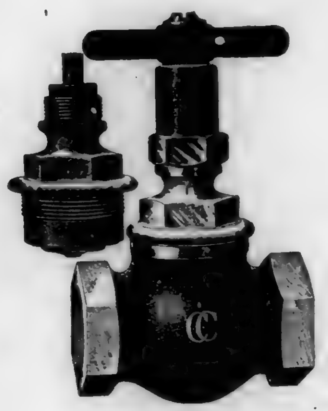


FIG. 4.

or disk and to replace any worn part. Being attached to the stem by a slot, the disc is easily removed and replaced. The disc and seat may be removed and ground together if necessary. When putting the valve together the seat is replaced and the nut on the bottom of the valve tightened up to hold the seat in place. The bonnet is then screwed on and the valve closed. These valves may be packed without steam escaping; to do this the valve is opened wide.

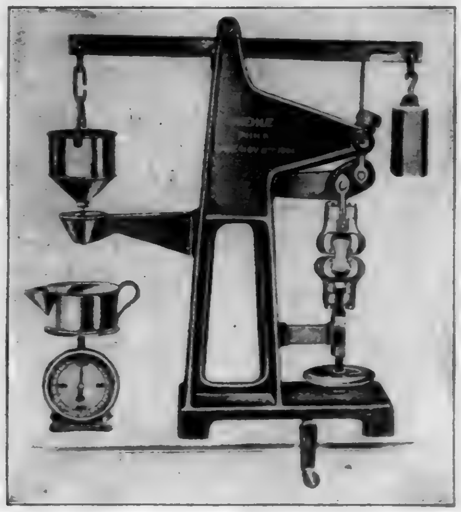
The Crane straightway valves with renewable seat and wedges are made with copper seats and hard metal wedges. They are suitable for working pressure of 250 lbs., and are tested to 800 lbs. Fig. 2 illustrates an easy method of inserting these renewable parts in these valves. Soft metal rings or seats are furnished, for air or water in these valves.

Figs. 3 and 4 illustrate self-packing radiator valves, employing Jenkins discs and non-rising stems. Leaky stuffing boxes are avoided by the use of rubber pieces between the metallic parts, which ordinarily grind together and become leaky. This vulcanized rubber prevents leakage and may be renewed when it becomes worn. The bonnet threads of these self-packing valves are the same as those of the Jenkins disc valve made by the Crane Company, and the self-packing device is also applicable to the Crane brass wedge gate valves with non-rising stems.

RIEHLE U. S. STANDARD AUTOMATIC CEMENT TESTER.

This illustration shows the Riehle U. S. Standard 1,000 lbs. (500 kilos) automatic cement tester. It is constructed entirely of metal, and is of superior design and finish.

The beam is brought to a balance by pouring shot into the cone shaped bucket on the left, thus counterbalancing the weight on the right hand side. The test briquette is then placed in the grips and by means of the handwheel under the lower grip the slack is taken up. A piston valve in the bucket is then lifted and the shot flows out of the bucket, causing the weight to overbalance the bucket and load thus to be applied to the specimen. When a sufficient weight of shot has flowed out of the bucket, the unbalanced force of the weight is sufficient to break the briquette, and then the lightened bucket is jerked by the weight and the piston valve in it closed, causing the flow of shot to cease. The weight of shot which has flowed out is a measure of the force required to break the briquette, and this shot is caught in a scoop on a scale which is graduated to read directly the stress on the briquette. If at any time the briquette should be so yielding as to allow the beam to strike the lower buffer before the



NEW RIEHLE CEMENT TESTER.

briquette is broken, the valve automatically closes and the flow of shot ceases. Then, if desired, the beam can be raised by means of the worm and wheel and the test continued. The piston valve (patent Nov. 8, 1904) for controlling the flow of shot is believed to be the simplest and most effective automatic valve made. If it is desired to make a test of extreme accuracy the beam may be kept horizontal during the test by means of the crank and worm wheel.

This description and operation applies to both sizes of cement testers. The weight of shot in the 1,000-lb. machine is as 1 to 100 lbs.; this means that 10 lbs. of shot on an ordinary scale would indicate a strain of 1,000 lbs. In the 2,000-lb. machine the proportion is 1 lb. to 80 lbs., viz., 25 lbs. of shot will indicate 2,000 lbs. strain.

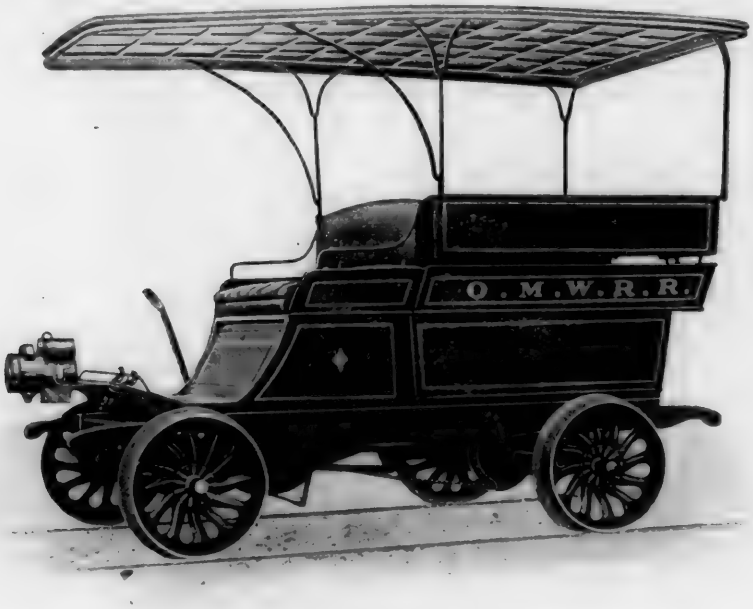
These machines have been placed on the market after proving themselves in exhaustive tests, which is characteristic of the methods of this firm. The name by which they are known is "Bestone," and the 1,000-lb. size is adapted to most general use among engineers.

Mr. C. S. Larrison has been appointed master mechanic of the Dakota division of the Northern Pacific Railway, with headquarters at Jamestown, N. D., to succeed Mr. J. E. O'Brien, promoted. Mr. Larrison was formerly general airbrake inspector of this road.

Mr. T. A. Lawes, who recently resigned as superintendent of motive power of the Chicago & Eastern Illinois, has been appointed mechanical engineer of the New York, Chicago & St. Louis Railroad, with headquarters at Cleveland, O., to succeed Mr. J. T. Carroll.

OLDSMOBILE INSPECTION CAR.

This illustration shows a new type of inspection car, known as Model No. 2, tonneau car. It is, in general, similar to the Oldsmobile railroad inspection car No. 1, except that it has a tonneau added, giving a capacity of eight passengers. The tonneau may be removed and replaced by a platform, to carry men and tools for ordinary repair work. This car is driven by a 7-h.p. gasoline engine, giving a speed of 35 miles per hour, which is variable and under control, the engine and gearing being the same as that used in the Oldsmobile runabout. The car is built for standard gauge. It has a 62-in. wheelbase, oak sills, 20-in. pressed steel wheels, cold rolled axles and powerful brakes. Its capacity for water and gasoline is sufficient for 100 miles. These cars are reported to have run 3,000 miles over a road having 3 per cent. grades. It is sold by the Railway Appliances Company, Old Colony Building, Chicago.



OLDSMOBILE INSPECTION CAR.

AN IMPROVED SMALL VERTICAL ENGINE.

A new design of small upright engine, in which special attention has been given to the oiling system, has been placed on the market by the American Blower Company, of Detroit, Mich. It has been developed specially for continuous service, such as driving dynamos, pumps and blowers.

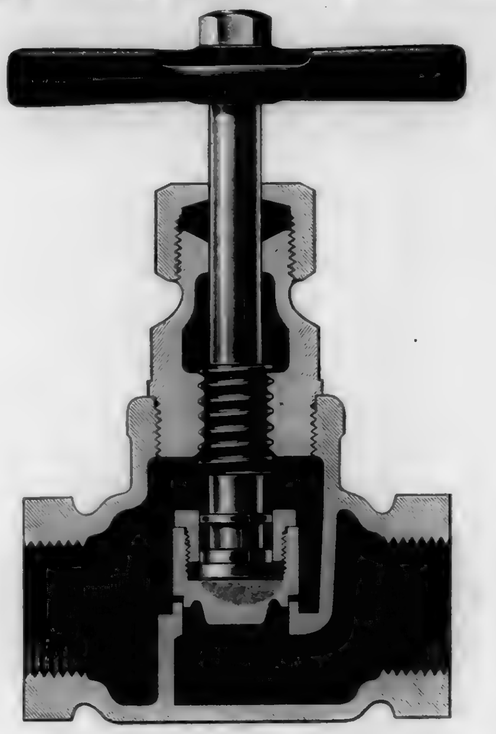
The working parts are entirely enclosed, as indicated in the phantom engraving. Oil is delivered to the bearings in streams. From an oil pump, A, the plunger, L, which is driven by an eccentric, K, on the shaft, forces the oil up through the tube, B, into the strainer, C, from which it drops into an oil box and passes through four tubes to the guides and bearings. Two of these tubes, F and G, take oil to the guides. Tube E supplies the crosshead pin, the oil dropping into the cup H. The oil dropping from the crosshead is caught in two pans attached to the inside of the covers. From these it runs down the inside of the cover, dropping into a cup in the top of the main bearing cap. Instead of using oil grooves at the top and bottom of the main bearing, as customary, in this system the bearing is cut away at the joint so that the oil is carried to the bottom of the bearing when the connecting rod thrust is upward, but when the load is reversed there are no grooves to carry away this oil. Tube D oils the crank pin and discharges into a crank oil ring inside of the eccentric, K, which in turn discharges into the crank pin oil tube and takes the oil across the crank pin bearing. By this independent supply the crank pin oil ring catches the drip from one end of the main bearing, the eccentric being oiled by the drip which it catches from the other end. No difficulty has been experienced in catching the oil thrown off of the eccentric strap and the splash from the crosshead has been equally easy to take care of, the outside of the engine being entirely free from oil. The large base affords a good opportunity to cool and settle the oil; a portion of it as it drops back into the bottom of the frame drops into an oil filter. This engine was subject to severe test and experiment for two years before being placed upon the market. It is stated that one of the engines was adjusted and filled with oil on March 10; up to July 15 no adjustment of any kind had been made, and no oil added except to fill the sight feed cylinder lubricator. The engine runs from 14 to 16 hours a day, driving a blower, and for four months ran almost as noiselessly as at first.

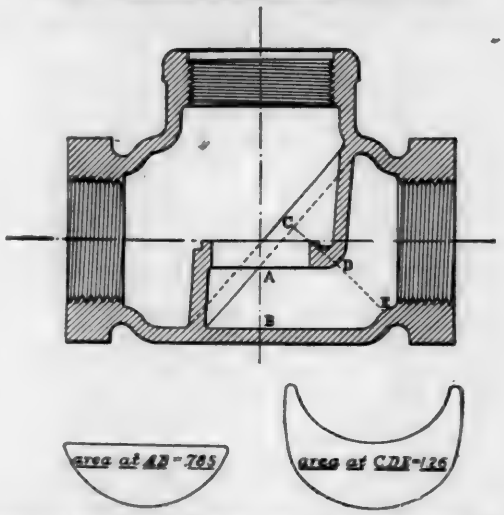
IMPROVED SMALL VERTICAL ENGINE.

HANCOCK VALVES.

These valves are made of special composition to secure strength and good wearing qualities. They are made in one standard only for all pressures. The manufacturers guarantee that every globe, angle, 60-deg. and cross valve has been tested with 1,000 lbs. pressure and found tight before leaving the works. They are guaranteed for 500 lbs. steam pressure. The bodies are made of hard and tough mixture to secure durable valve seats. The discs are of a special mixture which does not include zinc. Tobin bronze is used for the spindles. These valves are similar in design to the Hancock main steam valves used for a number of years on locomotives. The sectional sketch shows the areas of the most contracted parts of a 1-in. globe valve. The metal is distributed to give uniform strength, and the areas have not been reduced or contracted for the purpose of reducing weight. One of the sectional engravings shows two collars on the stem guiding the valve for the purpose of seating it squarely, to prevent the disc from cocking. The valve seat is flat, and is provided with a projection, which acts as a guide in the grinding and prevents the cutting of the seat by the wire-drawing of the steam when the valve is opened slightly. When the valve is slightly raised, as shown in the section, the escaping steam cleans the seat of dirt. The makers state that very little regrinding is required to restore tightness after the valve begins to leak. These valves have long threads in the bonnets, and by means of a narrow seat on the shoulder it is possible to keep the bonnet tight, and yet it is easy to unscrew it. This is considered a positive improvement over bonnets having wide shoulders bearing upon wide surfaces upon the top of the valve body. To regrind a valve to its seat, the bonnet is removed, the disc nut unscrewed from

the disc, and a piece of wood may be inserted in the disc, permitting it to be ground perfectly by aid of the projection on





the disc which guides it, thus avoiding the necessity for special regrinding tools. These valves have tee handles, the hole in the handle is tapered, with one side flat, and the handle is held to the spindle by means of a nut. The flattened side holds the handle rigidly in place, while the taper permits it to be drawn tightly to the spindle to avoid the annoyance of loose handles.

These valves are made by the Hancock Inspirator Company, 85 Liberty street, New York.

PERSONALS.

Mr. Thomas Jackson has been appointed shop superintendent of the Northern Pacific Railway at Livingston, Mont.

Mr. M. J. McGraw, master mechanic of the Illinois Central, has been transferred from East St. Louis to Clinton, Ill.

Mr. E. C. Walker has been appointed foreman of the car department of the Houston & Texas Central at Spencer, Texas.

Mr. H. J. Uhlenbrock has been appointed assistant master mechanic of the Wabash Railroad, with headquarters at Decatur, Ill.

Mr. J. J. Shaw has been appointed division foreman of the St. Louis & San Francisco at Neodosha, Kansas, succeeding Mr. C. E. Brown.

M. J. H. Nash has been appointed master mechanic of the Illinois Central at East St. Louis, Ill., to succeed Mr. M. J. McGraw, transferred.

Mr. W. J. Schlacks, master mechanic of the Colorado Midland, has been appointed superintendent of motive power, to succeed Mr. J. R. Groves.

Mr. Gustav Navarro has been appointed superintendent of motive power and machinery of the Vera Cruz & Pacific Railway at Tierra Blanca, Mexico.

Mr. A. H. Powell has been appointed master mechanic of the Chicago & Eastern Illinois Railroad at Villa Grove, Ill., to succeed Mr. J. W. Bell, resigned.

Mr. R. H. Rutherford has been appointed assistant master mechanic of the Mexico Division of the Mexican Central Railway with office at Aguascalientes.

Mr. John W. Bell, master mechanic of the Chicago & Eastern Illinois, has been transferred from Oak Lawn to Villa Grove, Ill., to succeed Mr. A. H. Powell, resigned.

Mr. J. E. Chisholm has been appointed master mechanic of the Oelwein shops of the Chicago Great Western Railway at Oelwein, Ia., to succeed Mr. R. M. Crosby.

Mr. J. M. Markey has been appointed master mechanic of the Northern Division of the Grand Trunk, with headquarters at Allendale, Ont., succeeding Mr. N. B. Whitsel.

Mr. H. O. Bowen has been appointed master car builder of the Missouri, Kansas & Texas Railroad, with headquarters at Sedalia, Mo., to succeed Mr. J. L. Wigton, resigned.

Mr. G. H. Bussing has been appointed superintendent of motive power of the Evansville & Terre Haute Railroad, with headquarters at Evansville, Ind., succeeding Mr. W. J. M. Leish.

Mr. J. Montgomery has been appointed master mechanic of the Northern Division of the Grand Trunk Railway, with headquarters at Allendale, Ont., to succeed Mr. N. B. Whitsel, resigned.

Mr. C. H. Burk, master mechanic of the Mexican Central Railway, is transferred from Aguascalientes to Mexico City, where he will succeed to the duties of Mr. G. W. Jennings, resigned.

Mr. E. W. Fitt has been appointed assistant superintendent of motive power of the Burlington & Missouri River Railroad, with headquarters at Lincoln, Neb. He is promoted from the position of chief draftsman.

Mr. John Whetstone has been appointed superintendent of motive power of the Norfolk & Southern Railway, with headquarters at Berkley, Va. His title has heretofore been acting superintendent of motive power.

Mr. J. E. O'Brien has been appointed assistant shop superintendent of the Northern Pacific Railway, in charge of the shops at South Tacoma. He is promoted from the position of master mechanic of the Dakota division.

Mr. Charles H. Quereau has been appointed engineer of tests of the New York Central & Hudson River Railroad, with headquarters at Albany, N. Y. For the past two years Mr. Quereau has been superintendent of shops at West Albany.

Mr. J. T. Carroll has resigned as mechanical engineer of the New York, Chicago & St. Louis Railroad, to accept the position of chief draftsman of the motive power department of the Lake Shore & Michigan Southern at Cleveland, O.

Mr. R. P. Blake has been appointed assistant shop superintendent of the Northern Pacific Railway at Brainerd, Minn., in charge of the shops at that point. He has heretofore served the road in the capacity of mechanical engineer at St. Paul.

Mr. J. R. Groves has been appointed superintendent of the motive power and car departments of the Denver & Rio Grande Western Railways, with office at Burnham, Col., succeeding Mr. F. Mertsheimer, resigned. Mr. Groves resigns as superintendent of machinery of the Colorado Midland to accept this office.

Mr. E. E. Davis has been appointed superintendent of motive power of the Buffalo, Rochester & Pittsburg Railroad, with headquarters at DuBois, Pa., to succeed Mr. F. T. Hyndman. Mr. Davis has been connected with the motive power departments of the Boston & Maine, the Philadelphia & Reading, and the New York Central & Hudson River railroads.

NEW CATALOGUES.

IN WRITING FOR THESE CATALOGUES PLEASE MENTION THIS PAPER.

ADJUSTABLE REAMER.—Bulletin from the Gisholt Machine Company of Madison, Wis., describing the Gisholt "Solid" adjustable reamer.

THOMPSON-RYAN DYNAMO.—Bulletin No. 14 issued by the Ridgway Dynamo & Engine Company, Ridgeway, Pa., describes in detail the construction of the Thompson-Ryan dynamo.

MACHINE TOOLS.—The Springfield Machine Tool Company, of Springfield, Ohio. are issuing a catalog which very completely describes their line of brass and iron working machinery.

GRINDERS.—Catalogue from Charles H. Besly & Company, So. Clinton st., Chicago, which describes the Gardner grinder, the Besly band grinders and the taps and dies made by the company.

A PAINT THAT PREVENTS RUST.—Circular issued by the Detroit Graphite Manufacturing Company, Detroit, Mich., concerning the use of their "Superior Graphite Paint."

VALVES.—The Hancock globe, angle, cross, 60-deg. and check valves are described in a catalogue issued by the Hancock Inspirator Company, 85 Liberty St., New York. These valves are tested and guaranteed tight under a hydraulic pressure of 1,000 pounds.

MECHANICAL STOKERS.—The Westinghouse Machine Company. East Pittsburgh. Pa., have just issued a very complete catalogue of 60 pages describing the Roney mechanical stoker and calling attention to the advantages to be gained by its use. A number of important installations are illustrated.

GRAPHITE LUBRICANTS.—A 30-page pamphlet has been received from the Joseph Dixon Crucible Company of Jersey City, N. J., devoted to the interests of their well known graphite products for lubricating purposes. This pamphlet presents the theory of this lubricant and explains the function of flake graphite.

FOUNDRY CHAPLETS.—W. W. Lindsay & Company. Harrison Building, Philadelphia, distribute a sixteen page pamphlet describing their foundry chaplets and anchors, which are extensively used by the Pennsylvania Railroad, Philadelphia & Reading, Baldwin Locomotive Works and other large users of castings from their own foundries.

PULVERIZING MACHINERY.—Catalogue No. 30 issued by the Jeffrey Manufacturing Company, Columbus, Ohio, describes the various lines of pulverizing machinery made by them. These include the crushing machinery made by Schoellhorn-Albrecht Machine Company, the patents of which have been acquired by the Jeffrey Company.

VARIABLE SPEED MOTORS.—Flyer No. 253 issued by the Crocker-Wheeler Company describes their new line of variable speed field control motors for single voltage circuits. These are intended for use where the installation of the multiple voltage system is not warranted. These motors are arranged in two classes, one adopted to give constant horse power throughout a speed range of 2 to 1, and the other through a speed range of 3 to 1.

WESTINGHOUSE TYPE S MOTORS.—Folder No. 4030 issued by the Westinghouse Electric & Manufacturing Company describes their type S motor for direct current circuits and illustrates its application to various machine tools.

GRAPHITE LUBRICATION.—The January issue of "Graphite" published by the Joseph Dixon Crucible Company of Jersey City, N. J., is a special number devoted entirely to graphite lubrication. Copies will be sent free to those interested.

COE'S WRENCHES.—Coe's Wrench Company, Worcester, Mass., has issued a four-page pamphlet illustrating and describing the ordinary screw wrench bearing this well known name. The wrenches are illustrated in a number of styles, the features of each, the different finishes and the prices being given. These have knife handles, steel handles and wooden handles; also the key model is shown. This company is prepared to send literature of their wrenches to users of these tools.

FARLOW DRAFT GEAR.—A leaflet issued by the Farlow Draft Gear Company, Monadnock building, Chicago, contains a reprint of the test on this gear from the December number of this journal, a large photographic view of the M. C. B. testing machine with the record of the M. C. B. tests of 1902 indicated upon it, and also a number of the claims made for the Farlow draft gear. Prominent among these is the absence of wrought followers, pockets, spring straps and bolts. Eleven contingencies which will take a car with an ordinary gear to the repair track are enumerated, with the claim that the Farlow gear reduces this number to two—the breakage of couplers. This gear is guaranteed for ten years against fair and unfair usage. In the photographic view referred to the record of the Farlow gear is shown as surpassing the others.

NOTES.

NORTHERN ELECTRICAL MANUFACTURING COMPANY.—The Tennessee Coal, Iron & Railroad Company, of Birmingham, Ala., have ordered three 150 k.w. Northern slow speed generators.

PHILLIP CAREY MANUFACTURING COMPANY.—This company announce they have been awarded the gold, silver and bronze medals by the St. Louis Exposition for the superiority and general excellency of its magnesia steam pipe and boiler coverings; also a gold medal on account of its magnesia flexible cement roofing.

Mr. Edward D. B. Brown has resigned as architect of the Lehigh Valley Railroad Company to accept the position of contracting engineer of Fairbanks, Morse & Company of Chicago. The work on the new repair shops of the Lehigh Valley Railroad Company at Sayre, Pa., on which Mr. Brown has been engaged for the past two and one-half years is practically completed.

Mr. J. P. Neff recently resigned as roundhouse foreman of the Chicago & Northwestern Railway at Boone, Iowa, to enter the service of the American Locomotive Equipment Company, Railway Exchange Building, Chicago. He is a graduate of Purdue University, and, having had about ten years' practical railroad experience, he is a valuable acquisition to this company.

CHICAGO PNEUMATIC TOOLS.—The London branch of the Chicago Pneumatic Tool Company recently transmitted an order for 705 tools. President Duntley, now in England, reports very successful demonstration with the new electric drills. Inasmuch as there is a large field for drills of this kind, it is expected that the business in electric drills will soon exceed that in pneumatic drills.

CLOCKER-WHEELER COMPANY.—This company announces that the largest electrical generators in the world driven by gas engines will be furnished by them to the California Gas & Electric Company of San Francisco. Three 4,000 k.w., 3-phase, 13,200 volt, 25-cycle revolving field alternators will be driven by 6,000 h.p. gas engines built by the Snow Engine Company.

Mr. John G. Sanborn, formerly of the Chicago Pneumatic Tool Company, and more recently with the Chicago Storage Battery Company, has accepted a position with S. F. Bowser & Company, Ft. Wayne, Ind., as railway representative for their oil house equipment and oil storage system. Mr. Sanford will make his headquarters in Chicago.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

FEBRUARY, 1905.

CONTENTS.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

III.

GENERAL CHARACTER OF THE BUILDINGS.

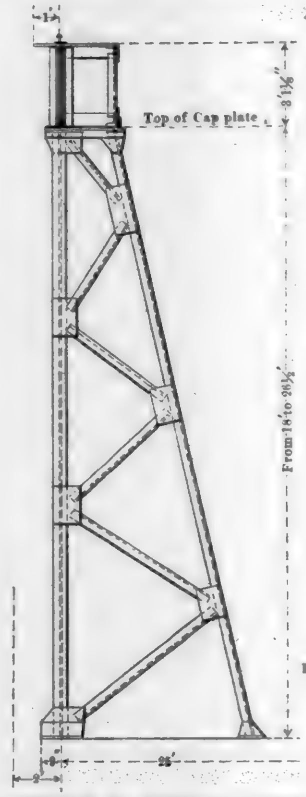
(*For previous article see January, 1905, page 1.*)

Sections of the remaining buildings, except the power house, are presented in the accompanying engravings, also detail drawings of some of the interesting features of the smaller buildings, including a typical wooden roof truss of the car machine shop, a section of one of the Midway crane supports, a column in the frog and switch shop, one in the hardwood storage building and a column showing the connections of the 20-in. I beams supporting the roof of the pattern storage building.

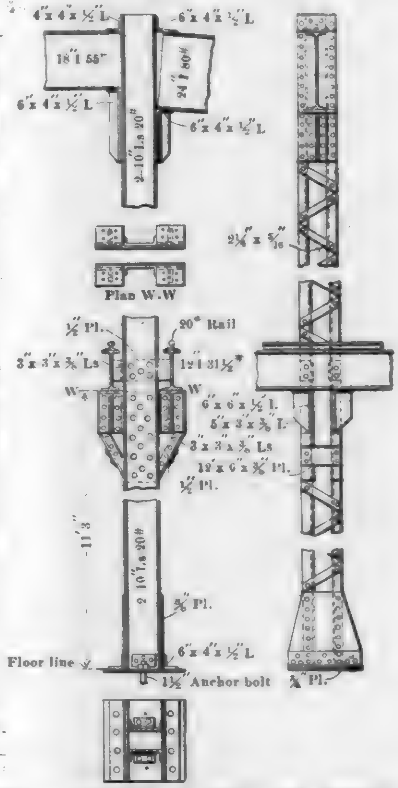
BLACKSMITH SHOP.—As already stated, this is an exceedingly large shop and is most admirably adapted to its purpose. It is built in two portions at right angles to each other; a cross section through the long portion, which is parallel to the midway, is illustrated. The floor is divided into one main bay 43 ft. 4 ins. wide, a side bay at the left 42 ft. 4 ins. wide, one at the right 43 ft. 2 ins. and a narrow bay of 15 ft. at the right for furnaces. In this section the lavatories are also placed. The roof is of 3-in. plank, except that of the furnace bay, which is of expanded metal in concrete. The lighting of this building is excellent. The main portion of the roof has a clear height of 32 ft., with swinging lantern lights over the roof and side bays. The total width of this building, outside of the walls, is 146 ft. 4 ins., as shown in the section, and the other, or shorter portion, is 130 ft. 8 ins. wide. As this building and its equipment are of special interest, it will be made the subject of a separate article later.

CABINET SHOP.—As already stated, this is the only building which is evidently too small; it is 62 x 580 ft., and provides at the eastern end for hardwood storage, with the upholstery department in the second story. The cabinet shop is divided from the other portion of the building by a brick fire wall. This building has two rows of columns and a 15-ft. longitudinal monitor from end to end. The windows are 8½ x 12 ft., with 3 ft. space between them. Those in the upper story are 10 ft. high. The cross section of this building shows the portion having two stories and gives the size of the columns and the principal timbers. It also shows the thickness of the walls and illustrates the construction of the floor. This building has a track throughout its length for handling material. The east end of the building is used for hardwood storage below and upholstery above. Its floor plan will be presented later in connection with the car shops. One of the small details illustrates the column and girder construction in the hardwood storage building, the columns of the lower story of which are of steel.

PASSENGER CAR SHOPS.—The photographic view shows the



SECTION OF RUNWAY—MIDWAY CRANE.

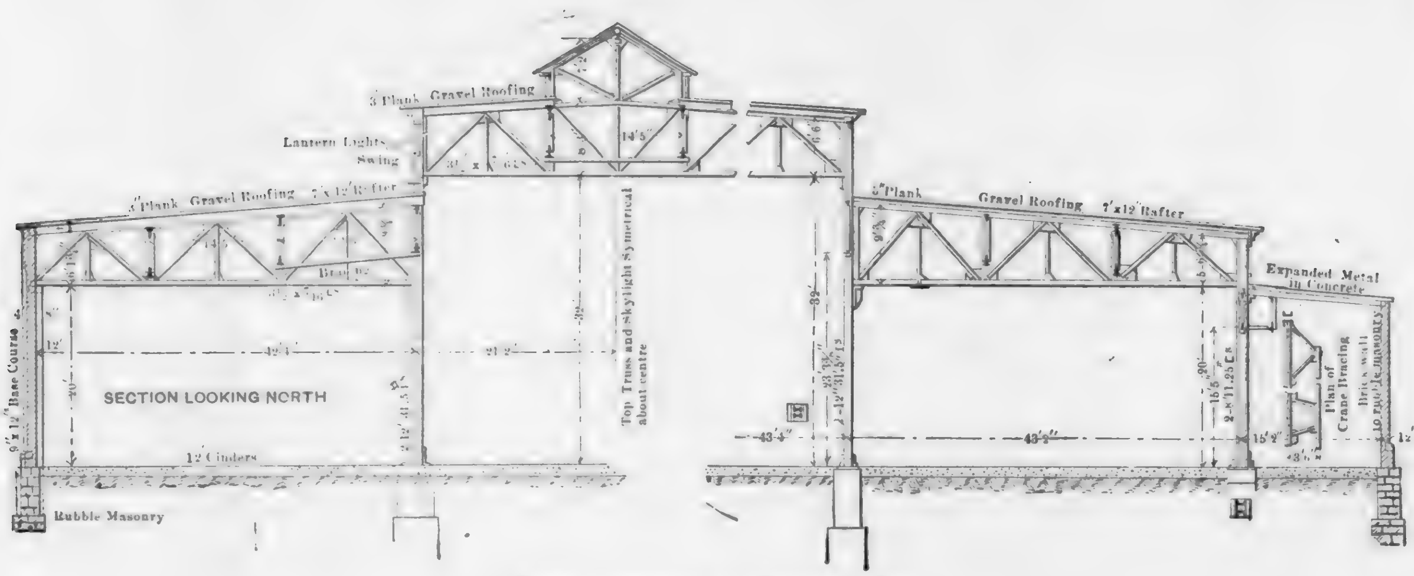


COLUMN IN FROG AND SWITCH SHOP.

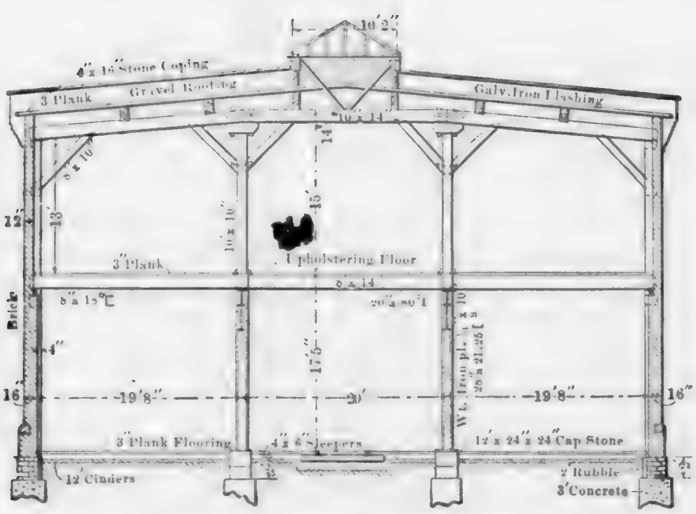
transfer table between the passenger car shops, looking east, with coaches standing outside of the building at the right and trucks and wheels at the left. This photograph presents an idea of the roofs of these buildings and their length, which is 672 ft. The cross section shows the brick walls and wooden posts and roofs. The section selected for engraving shows a brick fire wall, of which there are 3 in the erecting shop shown at the right of the transfer table, and 4 in the paint shop shown at the left. These will be referred to again in presenting the plans of the buildings. They are 12 ins. thick. Each building has 27 12 x 49-ft. transverse skylights, which, with the high windows, furnish admirable light. The construction of the skylights is shown in the sectional engraving. The skylights are arranged over the spaces between the coaches, both in the erecting shop and the paint shop, instead of over the coaches, as is usually done; this arrangement gives better light.

PLANING MILL.—This building is 126 x 500 ft. It has a central line of steel columns and has 2 standard gauge tracks passing through it from end to end, while a single transverse track crosses the building near the west end and ex-

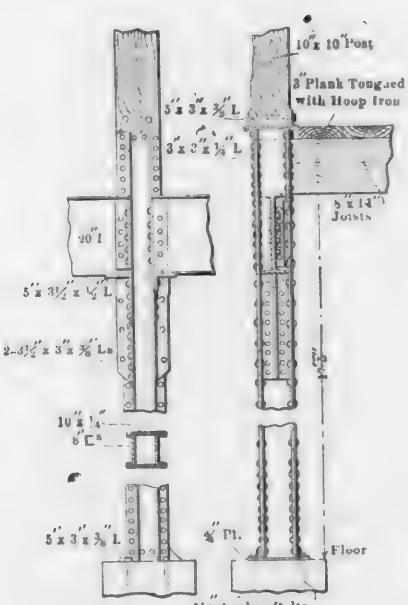
INTERIOR VIEW OF BLACKSMITH SHOP.



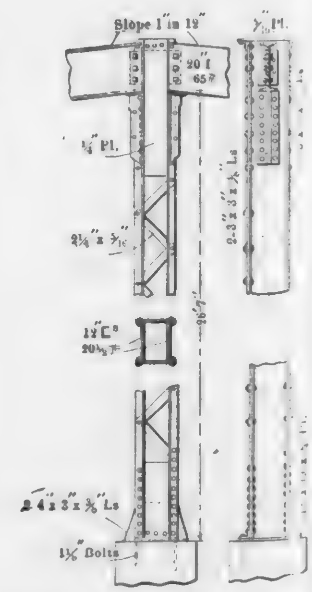
SECTION THROUGH BLACKSMITH SHOP.



SECTION THROUGH CABINET SHOP.



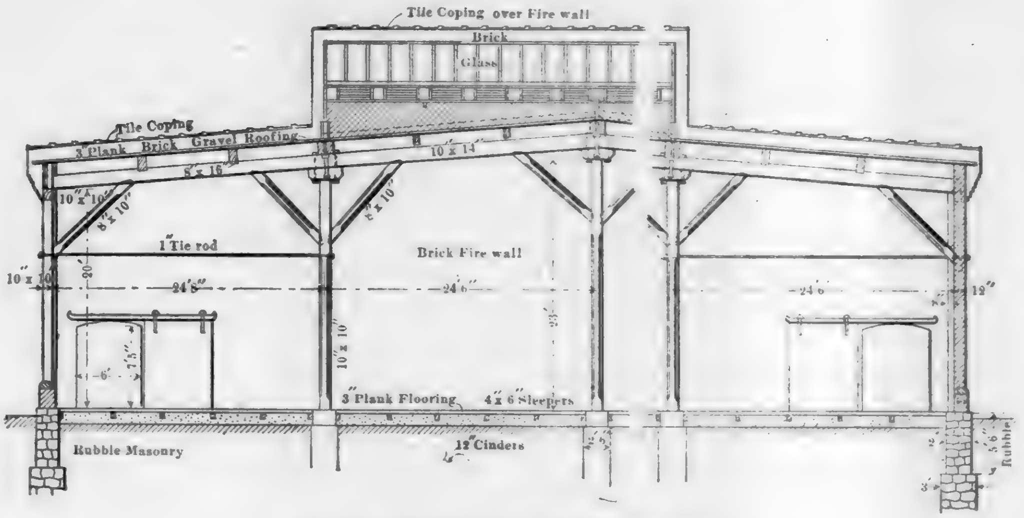
COLUMN AND GIRDER CONNECTIONS IN HARDWOOD STORAGE BUILDING.



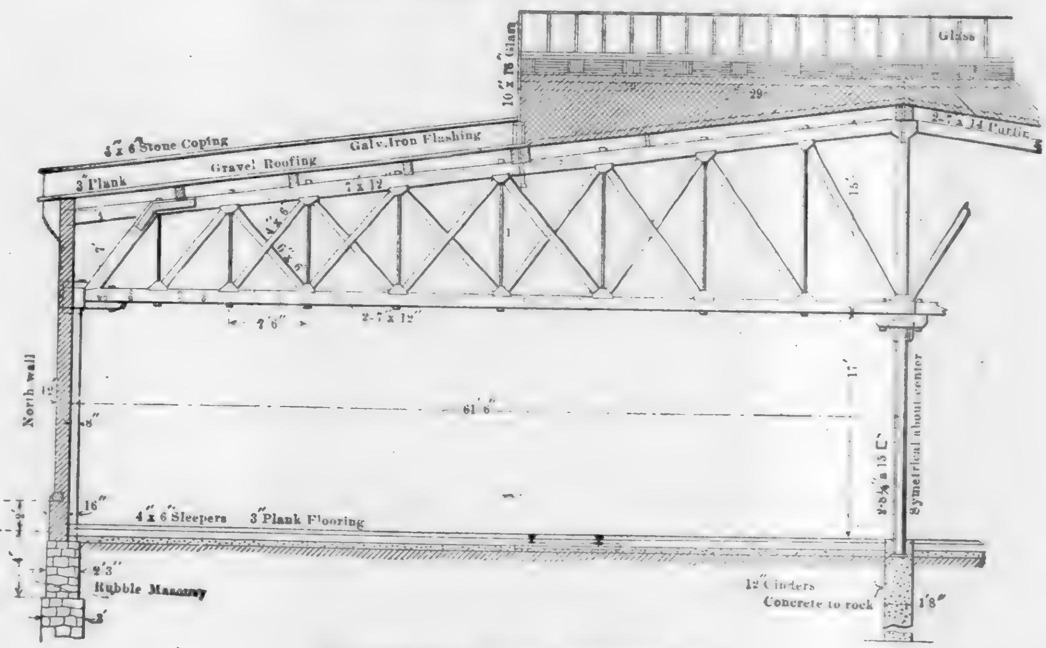
COLUMN IN PATTERN STORAGE BUILDING.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.—CANADIAN PACIFIC RAILWAY.

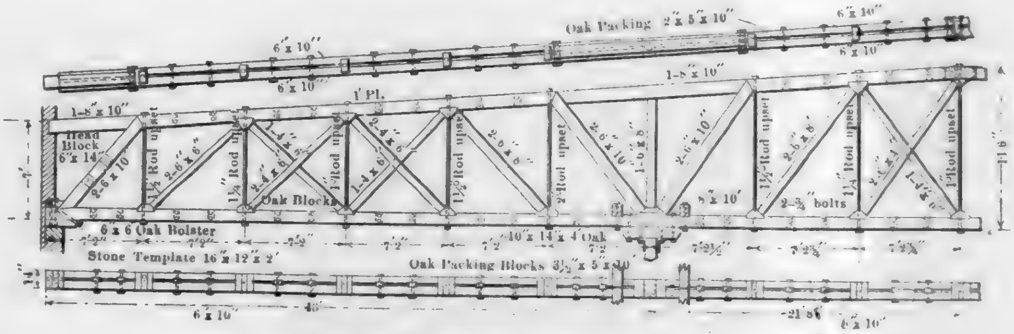
TRANSFER TABLE BETWEEN PASSENGER CAR SHOPS.



SECTION THROUGH PASSENGER CAR SHOP.



HALF-SECTION THROUGH PLANING MILL.



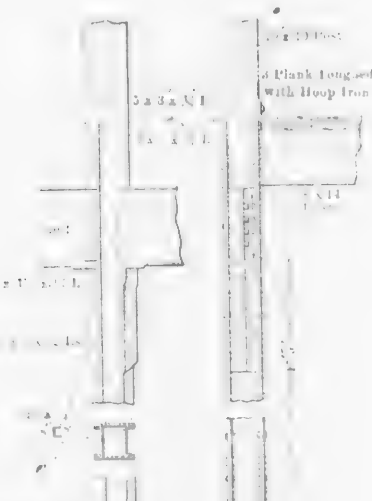
ROOF TRUSS FOR CAR MACHINE SHOP.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.—CANADIAN PACIFIC RAILWAY.

INTERIOR VIEW OF BLACKSMITH SHOP.

SECTION THROUGH BLACKSMITH SHOP.

SECTION THROUGH CABINET SHOP.

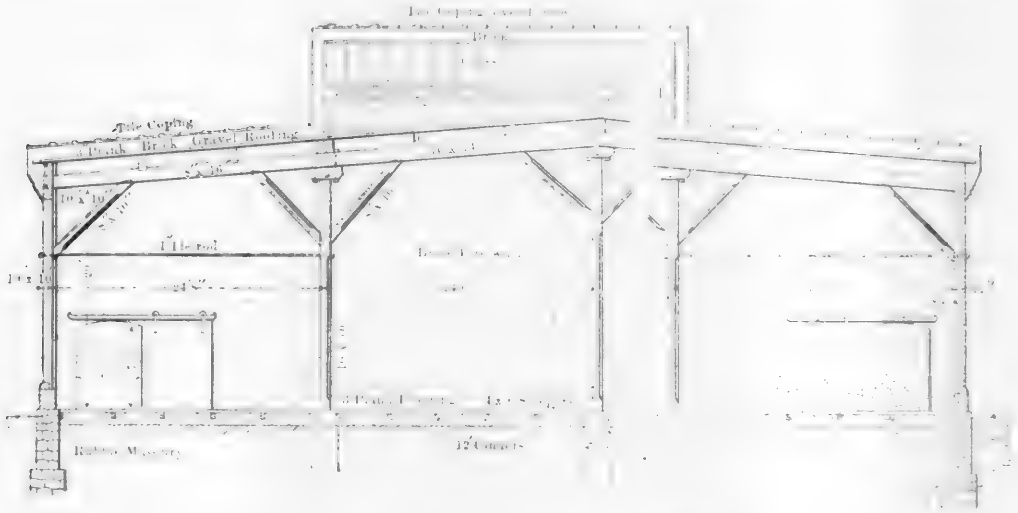


COLUMN AND GIRDER CONNECTIONS IN HARDWOOD STORAGE BUILDING.

COLUMN IN PATTERN STORE BUILDING.

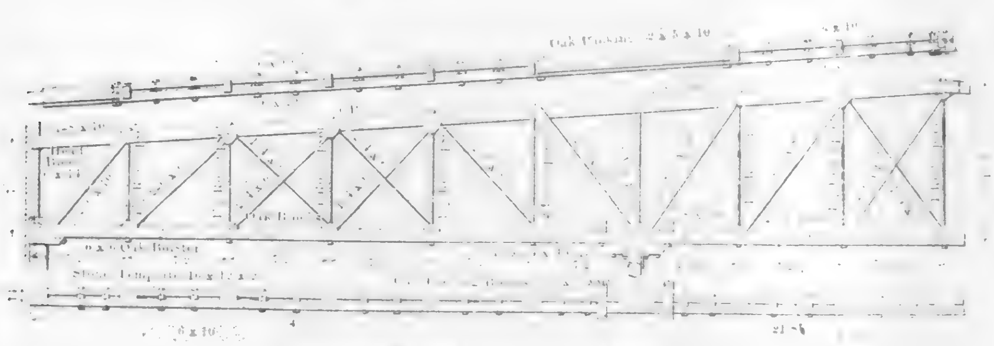
ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.—CANADIAN PACIFIC RAILWAY.

TRANSFER TABLE BETWEEN PASSENGER CAR SHOPS.



SECTION THROUGH PASSENGER CAR SHOP.

HALF-SECTION THROUGH PLANING MILL.



ROOF TRUSS FOR CAR MACHINE SHOP.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.—CANADIAN PACIFIC RAILWAY.

tends to the dry kiln. The roof trusses are of wood. This building is also very light. One of the detail engravings illustrates the roof trusses of the car machine shop, which is typical of the wooden roof trusses with the larger spans. A half cross section of the planing mill is shown with a skylight, of which there are 23, 10 ft. 4 ins. x 29 ft. in size, arranged transversely. These have glazed ends and the windows of this building are made as high as the height of the side walls will permit.

Drainage.—Two brick oval trunk sewers, 2 x 3 ft., lead to the city sewer south of the property. A large concrete covered ditch, 8 x 4 ft., leads the whole length of the property just west of the freight car shop and extends under the locomotive shop, discharging into a natural water course. The ground is generally level, with a slight ridge along the south side of the property. Surface drainage was therefore very important. Cedar boxes are provided, open at the bottom, surrounded by broken stone, and averaging 12 ins. square, being placed from 1 to 4 ft. down. The plot is covered with about 6 ins. of gravel, drained by these box drains, of which about 22,000 linear ft. are provided. Surface drainage from the boxes to the east enters the sewers through cedar manholes adjacent to the regular manholes, provided to settle the dirt. From the well the water flows into main concrete ditches.

Heating System.—The entire heating equipment was furnished by the B. F. Sturtevant Company of Hyde Park, Mass. The maximum distance to which steam is carried is almost exactly a half-mile from the power station. The extent of the heating contract is shown by the combined cubical contents of the buildings, which amounts to 28,400,000 cu. ft. In general terms the skylights occupy about 25 per cent. of the roof area and the windows one-half of the wall area. The heaters require a little over 37 miles of 1-in. pipe, furnished in sections of from 200 to 1,000 ft., in vertical coils, with cast iron bases, connected with fans, which will completely circulate all the air in any building 3 times every hour. The guarantee of the contractors require various temperatures from 60 to 70 deg. when the outside temperature is 10 deg. below zero. In the coldest weather no outside air will be handled by the fans. Separate exhaust and live steam mains are carried to every heater and live steam may be used in all of the heater coils. Returns from each building drain to small vacuum pumps and are carried through a general return main to the power house. Further remarks about the heating system will be made in connection with the subsequent descriptions.

Fire Protection.—The fire mains are entirely separate from the water service. A 12-in pipe connects to the city mains for fire protection only. This pipe has a pressure of 145 lbs. from a special high pressure city fire service. A 500,000-gal. reservoir, near the power house, is used as a reserve, and the main is fitted with a check valve retaining this supply in case of a failure of the city mains. Two 1,500-gal. underwriters' fire pumps pump from the reservoir if the city supply fails. As an additional precaution, two wells will furnish 20,000 gallons per hour if water is not to be had from the city service. Every building has sprinklers and over 13,000 of them are required in the plant, every 100 sq. ft. of roof area being served by an automatic sprinkler, which is always connected and ready with 145 lbs. pressure. All shops, except special buildings like the dry kilns, blacksmith shop, and others where the normal temperature is high, will open their sprinklers at 155 deg. The mill service consists of a 6-in. pipe leading from the low pressure city mains, connected with a 75,000-gal. tank, the bottom of which is 50 ft. from the ground. This is filled from the wells, or from the city mains; a check valve protects this supply in case of a failure of the main supply. This plant is an example of unusual precautions against fire, the plans having been made with special reference to the experience of fire insurance experts.

Telephone System.—The shops are equipped with a complete system of 50 local telephones, including a 75-drop switchboard in the office building, this being quite necessary in a plant of this size. The system has metallic circuit, self-restoring drops and motor generators for ringing.

REPORT OF COMMITTEE ON POWER.

Chicago, Rock Island & Pacific Railway.

(DEPRECIATION VALUE OF LOCOMOTIVES.)

(*For previous article see page* 8.)

To find the value of a locomotive at any age from one to twenty years, subtract from the original cost, or from the value determined in price per pound, the value when scrapped. Multiply this by the percentage in third column in Table No. 1 and add the scrap value.

Example.—Eight-wheel light locomotive and tender, 15 years old.

Weight of engine in working order	85,000 lbs.
Approximate value	$8,500 00
Scrap value at ¾c. = $637.00, say	640.00
$8,500 — $640 =	2,605.00

This is the assumed value of the engine when 15 years old, provided the boiler has not been renewed. If the boiler has been renewed, the cost of the new boiler and its application, less the scrap value of the old, is to be added to the depreciated value of the engine at the time the boiler is applied. The rate of depreciation per annum to remain constant, the increased life therefore would be due to the value added when the boiler is renewed.

Example.—Eight-wheel light locomotive and tender, 15 years old, with boiler renewed.

Weight of engine in working order	85,000 lbs.
Approximate value	$8,500.00
Scrap value	640.00
Value at 15 years without new boiler	2,605.00
Value at 15 years with new boiler	2,605.00

To which should be added the cost of rebuilding.

In scrapping small switch engines careful consideration should be given to the fact that the mileage is low and the demand upon the boiler small. This will probably have some influence in the limit of life. There will always exist a demand for some small switch engines of this character in certain localities around shops, factories, etc., requiring considerable light switching. In these localities it would not always pay to use large, heavy switchers.

In the valuation of locomotives several apparent inconsistencies may be observed, but as it is based on actual cost wherever practicable, and assumed cost consistent with the valuation at that time, we have considered it desirable to make no alterations in the value as shown by the records.

The general recommendations for scrapping power have been covered, but in determining the exact order in which engines should be scrapped, out of the large number which come within the recommendations of the committee, it is obvious, other things being equal, that the oldest and least efficient of this number should be the first to be scrapped and gotten out of the way. No doubt among the total number of engines recommended for scrapping a number will be found which, by reason of the good condition, can be kept in service for some time longer by running repairs, which at no time would approach, and certainly not exceed, 10 per cent of the original value.

Owing to the condition of track and bridges and light traffic, a number of small engines will be required for some time and it will no doubt be advisable to run these engines until they require repairs not exceeding 10 per cent. of their original value.

The report includes a large number of charts, showing in colors the total cost and present value of all of the locomotives on the system. These are based upon a limitation of life of 20 years for each locomotive, unless prolonged to 30 years by the application of a new boiler.

In purchasing locomotives in the future, the committee recommends replacing scrapped switch engines with new ones each of which will equal 2.3 of the old ones in tractive power. One of the proposed "medium" 2—8—0 engines will equal in tractive power 3.4 of the ones scrapped, and in numbers, 1[illegible] of the 2—8—0 class will do the work of 44 locomotives of the lighter classes recommended for scrapping. (This throws a strong light on the value of the recommendations of the report.—Editors.)

REDISTRIBUTION OF LOCOMOTIVES.

The committee was directed to consider "any possible redistribution of the power to secure the segregation of engines of similar character, in order to reduce the number of parts to be carried in stock and the cost of repairs."

One of the roads of the system has 89 separate motive power classes and 15 distributing points for repair parts. The conditions which have brought about this distribution of power would need to be thoroughly studied in order to make definite suggestions as to redistribution. The officers in charge can gradually bring together some classes of engines which are scattered without apparent good reason. Increased economies under this head may be obtained by active work in standardization of repair parts.

DEPRECIATED VALUE OF LOCOMOTIVES FROM 1 TO 20 YEARS.

Table No. 1.

Depreciation due to age, 5 per cent. of original value, less value of scrap at end of twenty years. Limit of age for light locomotives estimated at twenty years.

Years	% Depreciation.	% Original Value, Less worth of Scrap.	Example.—Original value, $8,500 ; Scrap Worth $640. Depreciated Value—scrap.	Depreciated Value—scrap.	Amount of Depreciation Each Year.
1	5	95	$7,467	$8,107	$393
2	5	90	7,074	7,714	393
3	5	85	6,681	7,321	393
4	5	80	6,288	6,928	393
5	5	75	5,895	6,535	393
6	5	70	5,502	6,142	393
7	5	65	5,109	5,749	393
8	5	60	4,716	5,356	393
9	5	55	4,328	4,963	393
10	5	50	3,930	4,570	393
11	5	45	3,537	4,177	393
12	5	40	3,144	3,784	393
13	5	35	2,751	3,391	393
14	5	30	2,358	2,998	393
15	5	25	1,965	2,605	393
16	5	20	1,572	2,212	393
17	5	15	1,179	1,819	393
18	5	10	786	1,426	393
19	5	5	393	1,013	393
20	5	0	0	640	393

One of the distribution charts shows the conditions at —— —— upon which point 17 separate motive power classes depend for repair parts. We believe it possible to redistribute these engines in such a manner as to retain but five classes at this point, and at the same time provide sufficient diversity of power to suit the different classes of service required. This would mean that repair parts for five classes of engines would be required in stock at ——— in place of parts for 17 classes, as at present.

The report shows that of the locomotives acquired by the various lines of the system during the past five years there were 68 distinctly different classes.

"CHANGES IN DESIGN OF EXISTING POWER THAT WILL INCREASE THE CAPACITY AND USEFULNESS AND PROLONG ITS LIFE."

This committee, after consideration of the various types of engines now on the system, cannot offer suggestions other than in a general way, covering the scope of this question. The engines are generally used to the limit of their capacity in engine tonnage or the capacity of the roadbed on which they are used. We do not know of any measure by which the life of the power could be prolonged other than in certain suggestions and standardization, referred to later.

We find that many light engines and some of the medium-weight engines are provided with tenders of insufficient water

COST OF REPAIRS ALLOWED ON LOCOMOTIVES WHEN 20 AND 25 YEARS OF AGE AND OVER.

Table No. 2.

Class.	Repairs When Over 20 Years. Cost.	25 Years. Cost.	Aver. Cost of Class.	Repairs Allowed. 20 Years Old.	25 Years Old.
15-in. eight-wheel....	....	5 %	$7,000	....	$350
16-in. eight-wheel....	....	5 %	8,000	....	400
17-in. eight-wheel....	10 %	5 %	9,000	$900	450
16-in. ten-wheel......	....	5 %	8,500	....	425
17-in. ten-wheel......	....	10 %	9,200	....	920
18-in. ten-wheel......	....	10 %	10,000	....	1,000
15-in. 4-wh. switch...	10 %	5 %	6,000	600	300
16-in. 4-wh. switch...	10 %	5 %	6,500	650	325
15-in. 6-wh. switch...	....	5 %	6,500	....	325
16-in. 6-wh. switch...	....	5 %	7,000	....	350
17-in. 6-wh. switch...	....	10 %	7,500	....	750
18-in. 6-wh. switch...	....	10 %	8,000	....	800
17-in. mogul........	10 %	5 %	8,000	800	400
18-in. mogul........	10 %	5 %	9,000	900	450

The amount of repairs allowed on old locomotives and the extension of the age limitation in this statement has been increased beyond the limits imposed on the rest of the power by reason of the demands for light power and the present condition of tracks and bridges and of light business generally on branch lines.

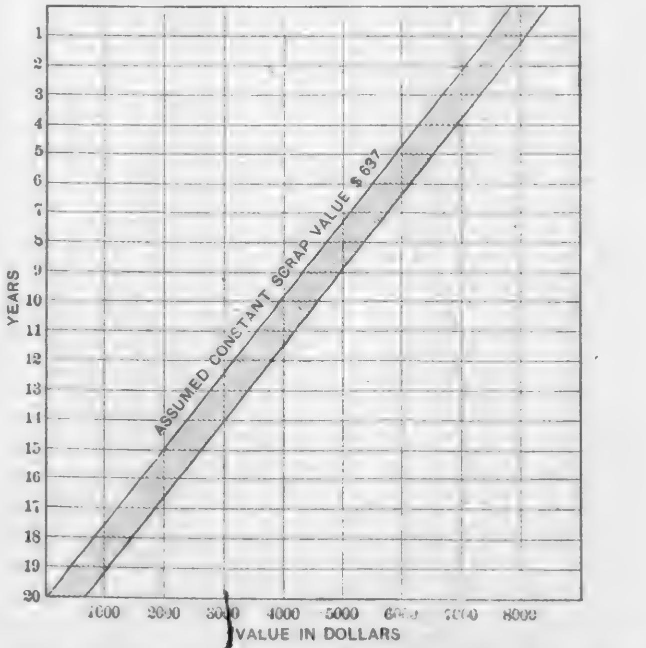


DIAGRAM SHOWING DEPRECIATION OF LOCOMOTIVES FROM 1 TO 20 YEARS. ORIGINAL VALUE, $8,500; SCRAP VALUE, $637.

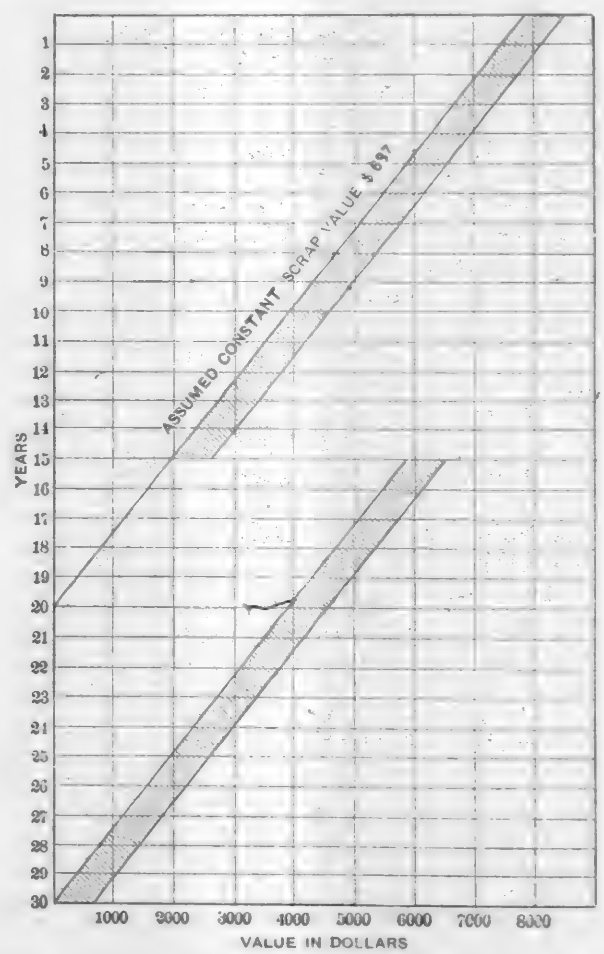


DIAGRAM SHOWING DEPRECIATION OF LOCOMOTIVES FROM 1 TO 30 YEARS. ORIGINAL VALUE, $8,500; SCRAP VALUE, $637. BOILER RENEWED WHEN 15 YEARS OLD.

capacity for good service, and we would recommend the general policy of purchase of larger capacity tanks, which may be considered as standards in the purchase of future equipment. These to be applied where the heavier power is deficient in water capacity; tanks of these engines in turn to be put back on lighter engines, eliminating the light tenders with wooden tender frames, which are too old to maintain. It will be noted in the discussion of new power to be bought that we recommend tenders of three capacities, viz.:—

7,000 gals., tank 24 ft. long, 10 ft. wide.

6,000 gals., tank 24 ft. long, 10 ft. wide.

4,500 gals., tank 19 ft. 6 ins. long, 9 ft. 10 ins. wide (switch engines with sloping tank).

The 24 ft. length of these tanks is considered desirable to obtain the lowest practicable center of gravity and spread of trucks. The 6,000-gal. capacity tender is considered desirable for fast passenger service engines and the medium freight power.

It is evident that the systems must have a considerable proportion of relatively light power for branch line service and divisions having light rail and bridges, where the traffic conditions do not justify the use of heavy power. The proposed elimination of a large number of light engines will necessitate a redistribution of the medium and heavier power, realizing thereby the advantages of modern engines over greater territory. This is possible, as is shown by proposed improvements to track and bridges. There may be some territory where this rule may not apply, but instead of purchasing new light equipment, we would suggest that careful examination of old equipment would probably disclose some engines with sufficiently heavy machinery to warrant the application of new boilers, which, however, cannot greatly exceed the size, weight and steam pressure of the boilers now on the engines. We do not urge or press this procedure, believing that the best ultimate economy will be reached in improving track and bridges, so as to increase the use of the heavier power.

As a further means of increasing the usefulness of existing power, we might state that the further standardization of parts would keep the engines on the road a greater portion of the time, by not waiting the shipment of odd repair parts. Both systems have a large number of classes of engines, many of these by no means old, on which the repair parts differ. While such standardization means a large amount of study and arrangement, yet we believe that it could be done advantageously to some extent. The following items to be considered as engines go through the shops in general repair:

Cylinder heads, pistons, eccentrics and eccentric straps, engine truck wheels and axles, piston rod and valve stem packing, water connection between engine and tender, driving springs, engine truck springs, tender springs, automatic couplers on tenders and pilots, friction and draw castings between engine and tender, tender axles, tender trucks.

To submit a typical case of the value of standardization of repair parts, we would cite the question of locomotive grate bars. As will be seen elsewhere in this report, but one pattern of grate bar is proposed for all the standard parts of locomotives recommended, and this bar is also applicable to some of the late power received. The great variety of widths of fireboxes on the older equipment requires a very large number of patterns, and a heavy stock of grates at stores and roundhouses, which could be greatly reduced had the policy of having as few widths as possible been a standard practice. It is now too late to remedy this very much, and as the old engines are scrapped, these odd patterns will be eliminated.

On the other hand, there are many parts, fittings and trimmings, which may be made common to many, if not all engines, such as cylinder cocks, water gauge cocks, certain parts of the motion work, etc. Reducing these to the smallest number required will greatly reduce storehouse stock, and a considerable expenditure to bring about standardization will soon be repaid.

WATER PURIFICATION.

Purifying water in special plants for softening and settling, which removes a large percentage of the solid matter before it is delivered to the locomotive tender, is one of the most efficient means of increasing the usefulness of the present power. Too much emphasis cannot be placed on this matter. A very large proportion of expense due to boiler repairs, resetting flues, etc., could be avoided with pure water. The increased temperature of flues, and firebox sheets, caused by coating of scale, is very detrimental to the metal. It is the most prolific cause of leaky flues, cracked sheets, etc., which is now met with in locomotive operation. The loss of evaporation of water per pound of coal, due to scale on heating surface, would also be avoided. This is one of the most insidious losses, the magnitude of which is not always appreciated.

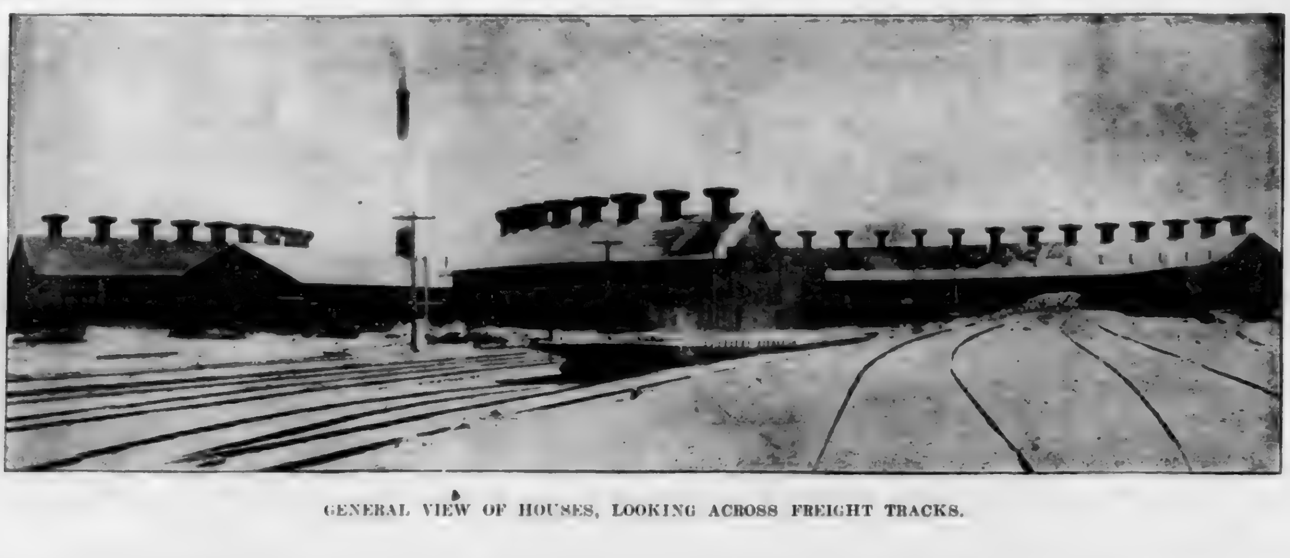
(To be continued.)

NEW ROUNDHOUSES AT ELKHART.

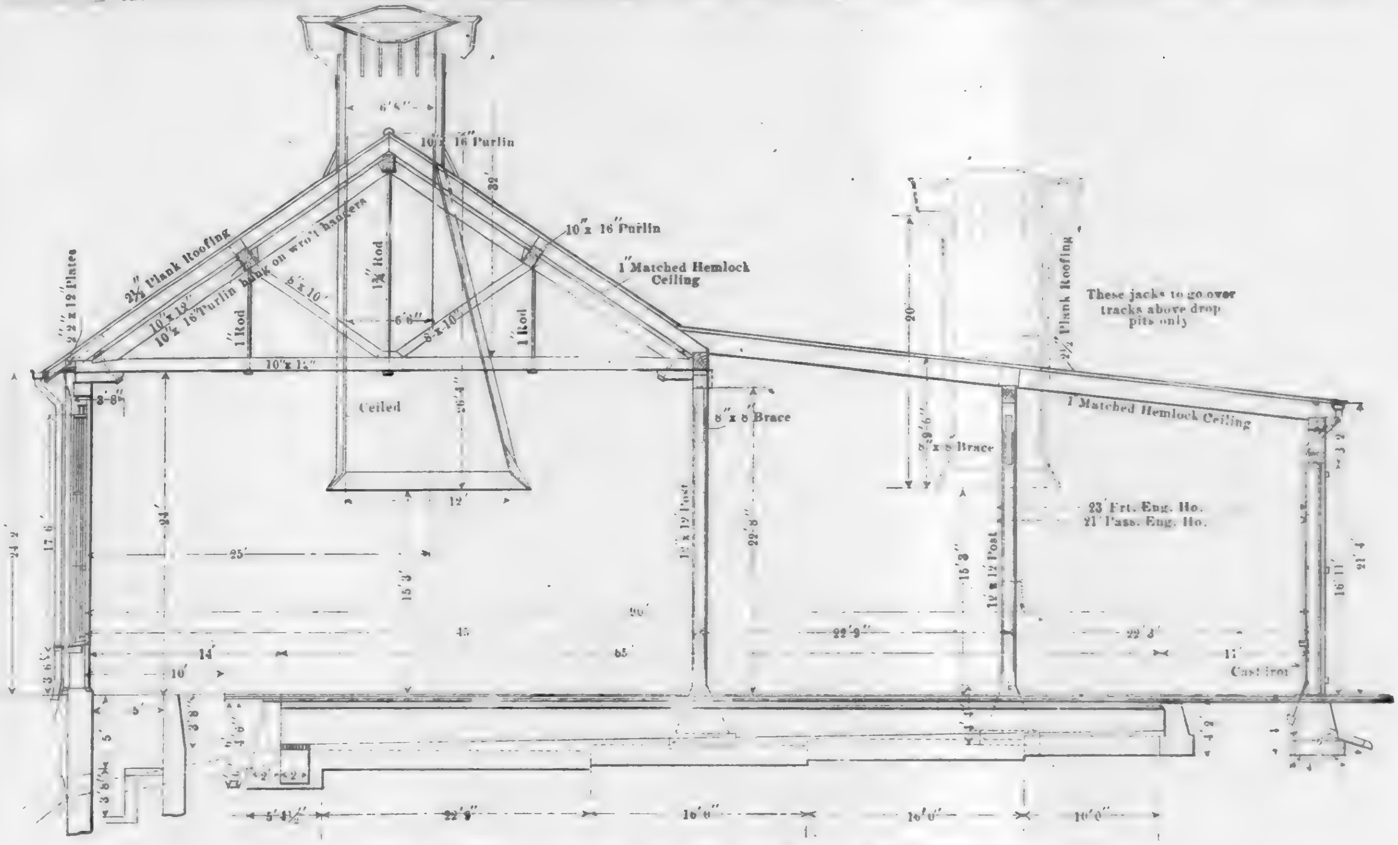
Lake Shore & Michigan Southern Railway.

If progressive general managers had witnessed the work which the writer saw last month at this new roundhouse, the construction of this plant would mark a new epoch in locomotive operation.

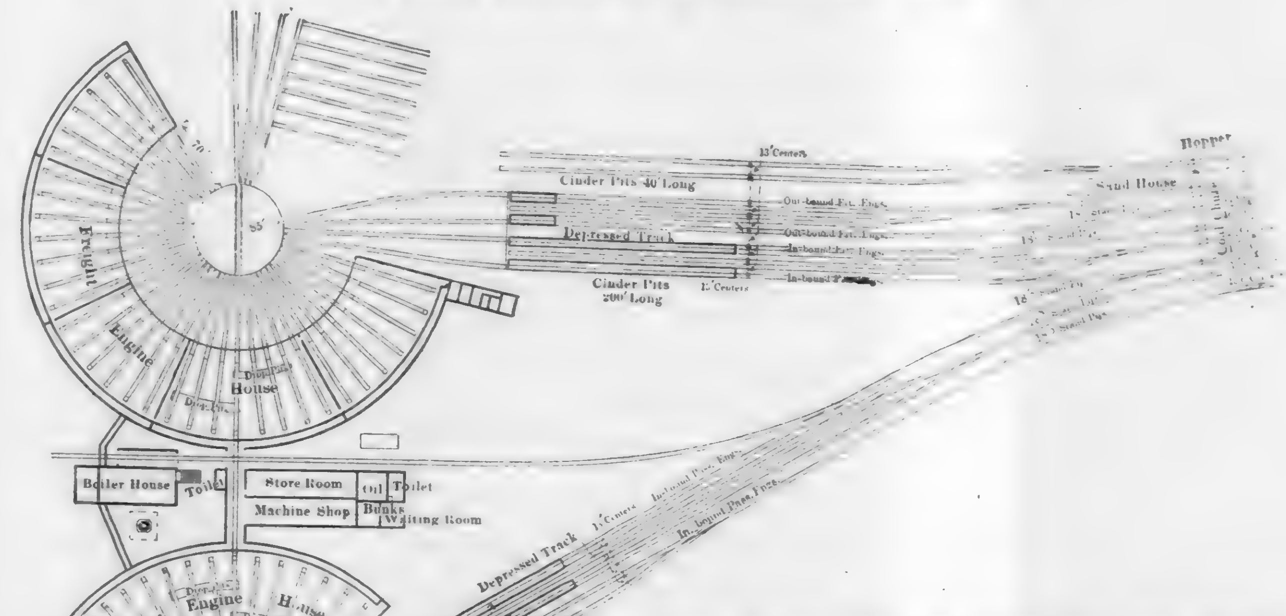
January 16, consolidation Engine No. 711 (see American Engineer, February, 1900, page 37) was brought to the house and the fire dumped at 9:45 a. m., with 178 lbs. of steam on the boiler. At 9:50 the engine was in the house. At 9:55 blowing-off commenced, steam from the dome and water from the blow-off cocks. At 10:27 the boiler was completely blown down. At 10:38 the washout plugs were out and washing out with hot water began at 10:40. At 11:17 the washing out was completed. The boiler was filled with hot water, the fire started with fagots, steam was taken from the flexible con-



GENERAL VIEW OF HOUSES, LOOKING ACROSS FREIGHT TRACKS.



CROSS SECTION OF HOUSE AND PIT, SHOWING SMOKE JACKS.



GENERAL PLAN OF TRACKS AND HOUSES, LOOKING SOUTH.

nection for the blower, and at 11:38 the engine was on the turntable with 65 lbs. of steam. The total time in the house was 1 hour 48 minutes. During this time 33 flues were caulked, the brick arch was removed and replaced by a new one, the flues were all blown out by air, the front end, and, in fact, the entire engine and tender, thoroughly inspected, the tank was thoroughly cleaned inside, the engine and tender wiped, a new set of piston rod packing was applied, and to wash the boiler over 30 washout plugs were removed. The house was at all times clear of steam and smoke. The performance was in every way thorough, and the record has never been approached. This shows the possibilities of these facilities. It was a clockwork job, and may be repeated at any time when required. Two hours will probably represent ordinary practice with these facilities. This will be appreciated when locomotives are wanted in times of stress for power.

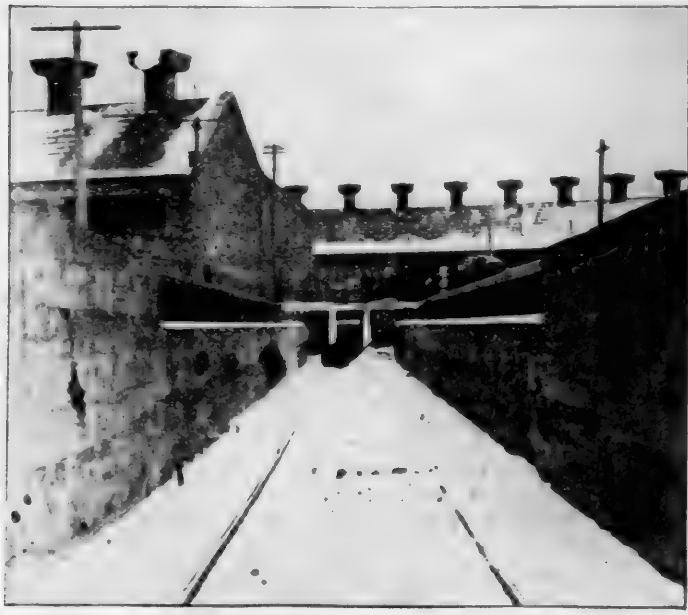
Elkhart is a main line freight and passenger division point, 101 miles east of Chicago. At this point a new "hump" yard for classification of both eastbound and westbound freight has been put into service, the ultimate capacity of which will be about 2,000 cars, classified, in each direction per day. The yards are about 2½ miles long, and they include about 50 miles of tracks. At the present time 161 locomotives, including both passenger and freight, are turned here daily.

The track arrangement was made to suit a triangular piece of ground upon the south side of the main tracks, immediately west of the Elkhart station. The plan is shown as seen from

the main tracks looking south, the roundhouses being at the east end of the triangle. The new freight yard is located west of the roundhouse territory, and freight engines will move directly east from the freight yard to the coal chute, which spans all of the tracks over which engines will pass to the roundhouses. They will take coal and sand, and then move a short distance to the standpipes for water, and thence over the cinder pits to the house. Passenger engines will leave their trains east of the roundhouse territory; they will move westward over the track which lies outside of the coal chute, and adjacent thereto, over which they will move to the coal chute switches. They will then move eastward over the cinder pits to the passenger house, which is the house with sixteen pits. This double movement could not be avoided without providing separate coal chutes for the passenger and freight houses. There was not room for two chutes, and this arrangement renders one conveniently available for all locomotives. It is obvious that in case of a breakdown of one of the turntables, one of the houses can be used for all engines.

The question of using separate houses was most carefully considered, and inasmuch as the number of passenger engines is sufficiently large to require an independent force of men, it was considered desirable to provide a special house for them. In doing this, the heavy work on both passenger and freight engines can be carried on in close proximity to the shop facilities.

The arrangement of the shops, power house and other buildings is convenient. A special track is provided for delivery to the oil house, store house, machine shop and power house. This crosses the passageway between the two houses, and the arrangement places the power house in space which would otherwise be valueless.



ONE OF THE 200-FT. ASH PITS.

COAL CHUTES.

REAR VIEW OF BOILER HOUSE.

ASH HOIST IN BOILER HOUSE.

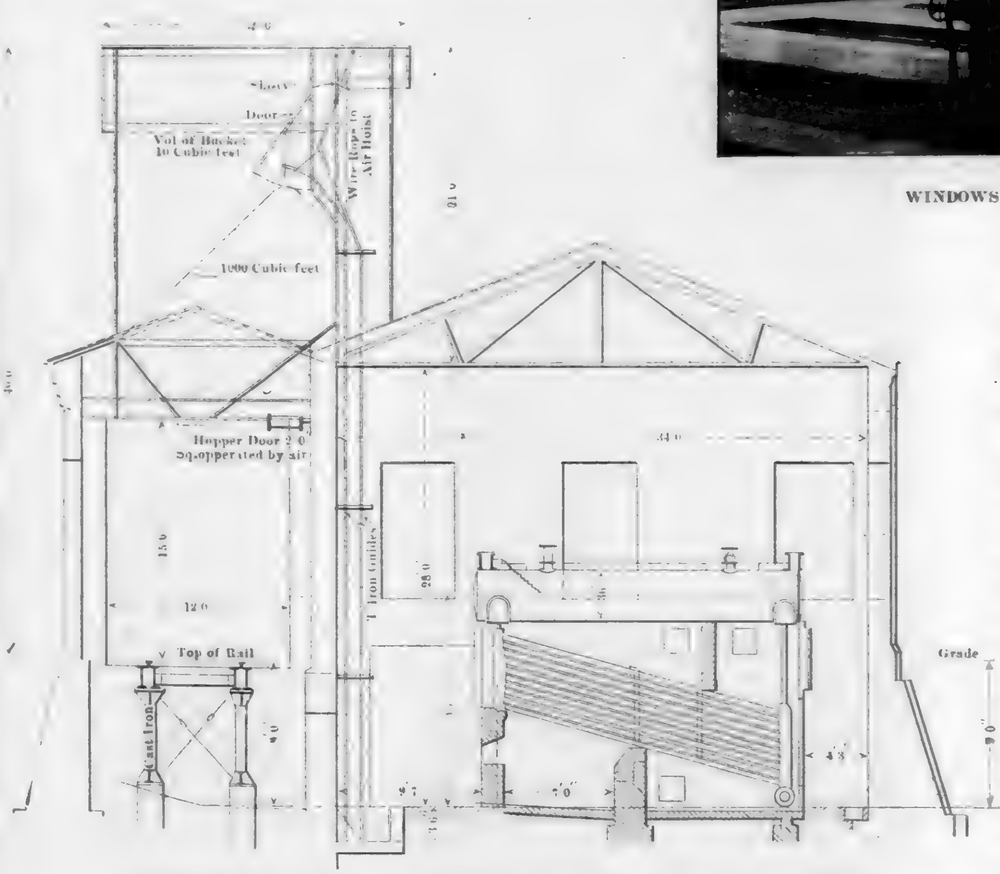
The machine shop is 25 ft. wide by 102 ft. long, the storeroom being of approximately the same size; the boiler house is 34 ft. by 72 ft. 6 ins., with an annex 34 ft. by 20 ft. 9 ins., to provide for the heaters of the boiler washing system. A waiting room, 21 ft. 6 ins. by 15 ft. 11 ins. in size, for engineers and firemen is provided. The oil house is 28 ft. by 26 ft. 8 ins., and the toilet room has a space of 13 ft. 9 ins. by 26 ft. 8 ins. An outside toilet room is also provided in a space of 18 ft. by 9 ft. 9 ins. Offices are provided at the freight house.

Special attention should be directed to the drop-pits, of

which four are provided in each of the houses, and located near the machine shop. At such a large terminal, it is desirable to facilitate the heavy work, and this arrangement is used to avoid delays due to locomotives waiting for drop-pits. The drop-pit tracks have two smoke-jacks each, in order that engines may be headed in either direction.

The passenger house has sixteen pits, and the freight house thirty-four. Both houses will be provided with additional tracks, reached by the turntables, for storage outside of the houses. These are indicated in the plan. The radius of each house is 202 ft. 7 ins. to the inside of the outer wall. The inside radius is 111 ft. 7 ins. The outer walls are 12 ins. thick. The houses themselves are of 90-ft. span, and the turntables are 85 ft. long. The angles of the houses are 6 deg. 40 min. The pits are 65 ft. long, with 11 ft. of floor space toward the turntable and 14 ft. outside. There is 24 ft. of head room under the trusses, and 15 ft. 3 ins. under the smoke-jacks. The pits drain toward the turntable. The windows are large and high.

The question of one or two houses was an important one, which received very careful consideration, and is worthy of special attention in a study of this plan. The additional cost for two buildings is not very much larger than for the same facilities provided in a single house, except the cost of the additional turntable and a portion of the cost of the additional cinder pits for the second house. If a single house had been used, an extensive arrangement of cinder pits and coaling appliances would have been required, in order to provide prompt movement when engines come to the terminal in bunches to congest the cinder pit district. In the winter, frequently a lot of freight engines will arrive simultaneously with



CROSS SECTION THROUGH BOILER HOUSE, COAL TRACK AND ASH POCKET.

a number of passenger engines, all of which will need prompt coal and ash pit service. Probably preference would ordinarily be given to the passenger engines, which would delay the freight. With two houses, and separate cinder pits, the work may go farward independently upon both. Switch engines are often brought in in numbers at one time. In the plan described, these may be run over any of the cinder pits which happen to be available, either the long ones or the short ones. The short pits in this case are intended for engines which have stood in the house long enough to require dumping of ash pans. These pits may be used without moving engines off of the long pits. It is interesting to note that the plain shovel pits, with depressed tracks, are used here without hoisting devices. The arguments for and against two houses are summed up as follows:

Advantages—1. Separation of passenger and freight engines to avoid slow movement of either. 2. Avoidance of the danger of tieing up the plant through the failure of one turntable because of ice or breakdown. 3. The heavy work section of each house is brought near the machine shop, concentrating the work.

Disadvantages.—Slight additional cost of two turntables.

WINDOWS AND SMOKE-JACKS.

This house has a high roof over the front ends of the engines, giving a large volume of air over the engines, and causes a tendency for steam to rise to the highest point, where it will escape through ventilators around the jacks. As a matter of fact, the houses are remarkably clear of steam and smoke.

The heating system is of the direct steam type, this and the washout system having been supplied by the Erie Heating Company. The foundation work, turntable pits and ash pits are of concrete. The engine house main buildings, as well as the other buildings, are of brick, with wooden roof trusses. The power house roof is of steel, covered with tile, while the other roofs are of wood, covered with gravel and tar. Concrete construction was used for the ash bin in the power house. The floor of the power house is depressed, in order to facilitate the handling of coal without a trestle. The ashes are raised into a pocket holding a full carload, which may be dumped into an empty coal car. Attention will be directed to many important details in another article.

One of the features of these houses is the division by fire walls into sections of eight pits each. This renders it possible to save heating such portions as may not be filled with engines. It is intended to group engines requiring heavy work in the sections nearest the shops.

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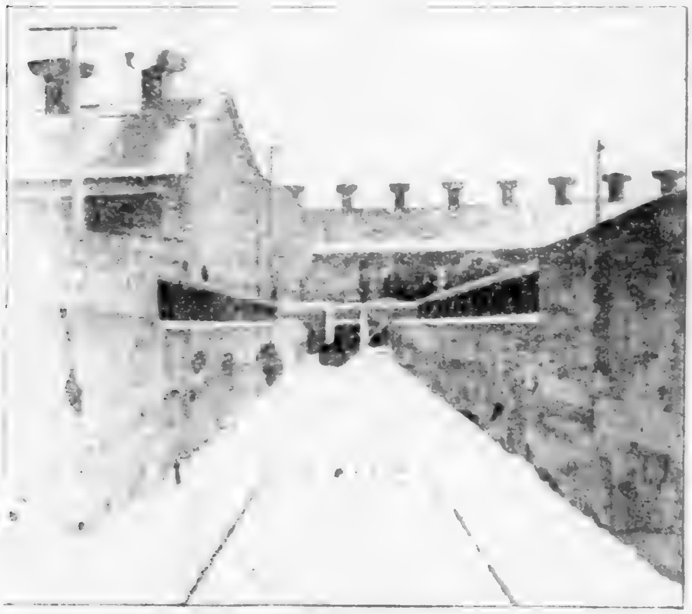

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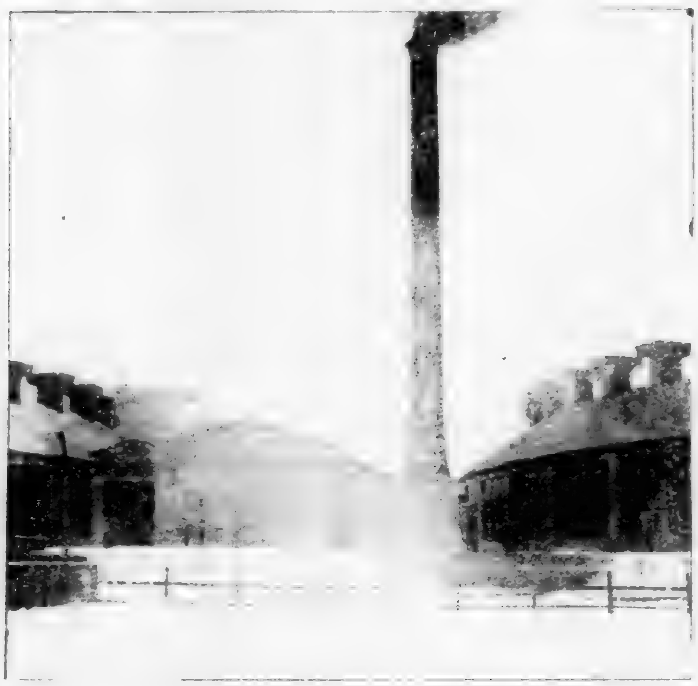
COAL CHUTES.



REAR VIEW OF BOILER HOUSE.

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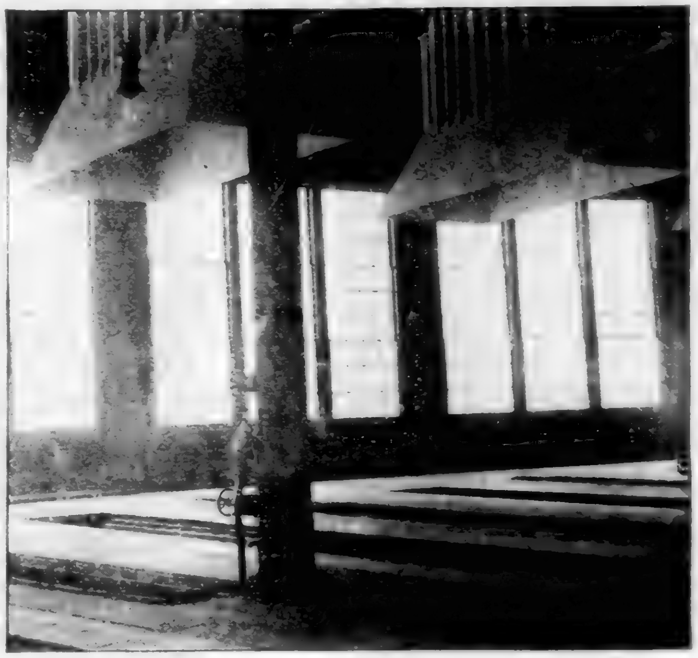

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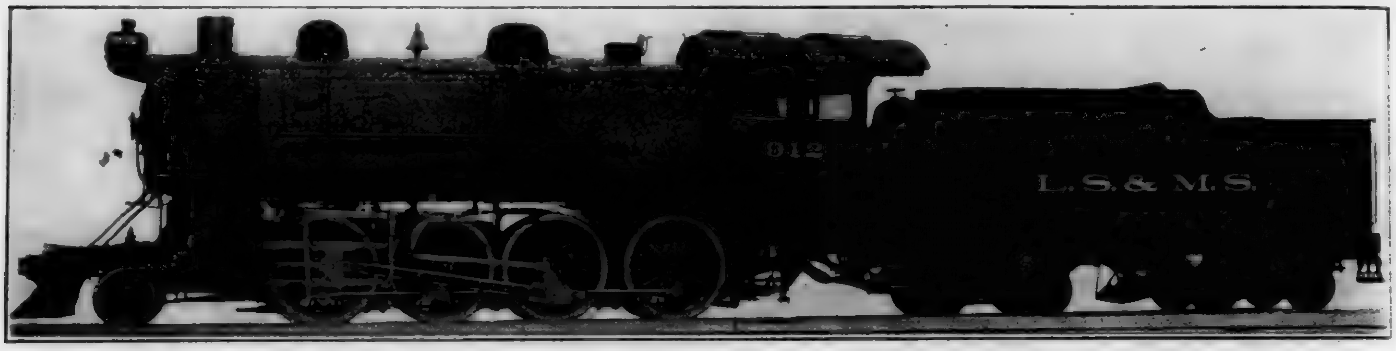
FREIGHT LOCOMOTIVE WITH WALSCHAERT VALVE MOTION.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Walschaert link motion combines two entirely distinct motions—that derived from a single eccentric and the other from the crosshead—in such a manner (see Auchincloss) that their combined effect is quite analogous to the motion obtained from the stationary link. The eccentric is usually applied in the form of a return crank from the main crank be accompanied by similar effects in the motion of the valve, which prevents the irregularity from deranging the events of the stroke.

American practice has favored the Stephenson motion, with its variable lead, and the Lake Shore & Michigan Southern is understood as turning toward the Walschaert gear for constructive reasons. Large freight engines afford little room for eccentrics between the driving wheels. While there is sufficient space for the parts, they are very inaccessible, and the result is that they are not properly inspected. Walschaert gear strongly recommends itself on the score of accessibility,



LAKE SHORE LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.—AMERICAN LOCOMOTIVE COMPANY, *Builders.*

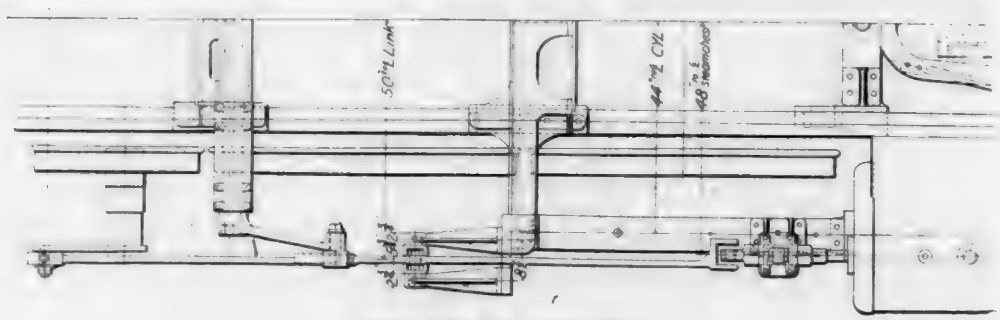
VALVE SETTING OF ENGINE 912, WITH WALSCHAERT VALVE MOTION.
(Measurements Furnished by the Railroad Company).

Position. Forward Motion— R. H. Side.	Pre-Admission. Front.	Pre-Admission. Back.	Lead. Front.	Lead. Back.	Port Opening. Front.	Port Opening. Back.	Cut Off. Front.	Cut Off. Back.	Release. Front.	Release. Back.	Closure. Front.	Closure. Back.
Full gear	3-64	3-64	9-64	9-64	2	1 13-16	27⅞	27	30⅝	30½	1½	1 9-32
⅝ stroke	3-32	3-32	9-64	9-64	¾	⅞	21 1-16	20⅝	28¾	28	4	3¼
½ stroke	3-16	3-16	9-64	9-64	17-32	9-16	16 3-32	16⅝	26⅞	26¼	5¾	5⅛
⅓ stroke	¼	¼	9-64	9-64	21-64	11-32	10⅝	11 7-16	24¼	23¾	8¼	7¾
¼ stroke	11-16	11-16	9-64	9-64	7-32	7-32	5 13-16	6 11-16	21	20⅞	11⅛	11

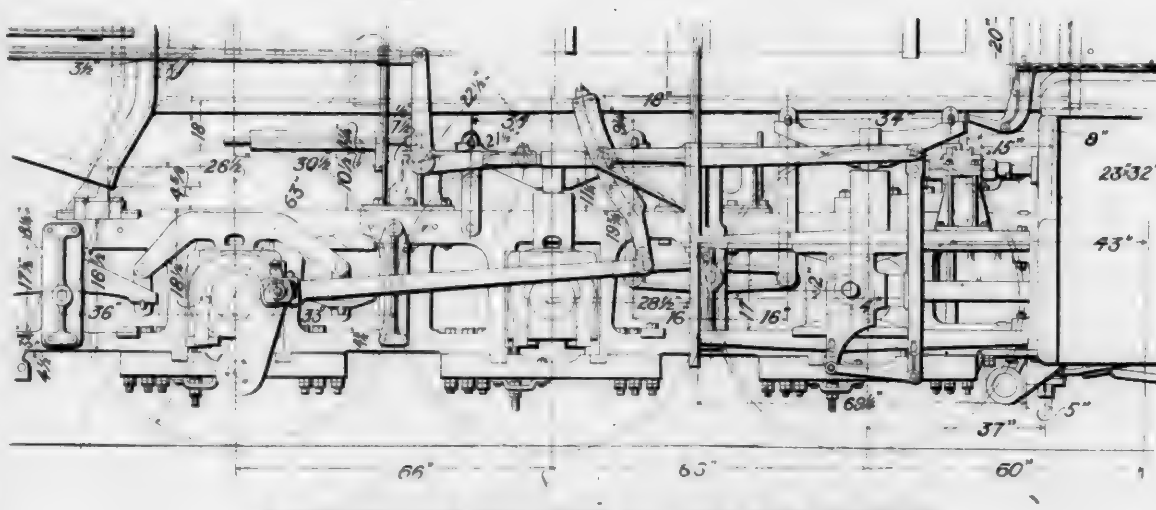
Position. Backward Motion— R. H. Side.	Pre-Admission. Front.	Pre-Admission. Back.	Lead. Front.	Lead. Back.	Port Opening. Front.	Port Opening. Back.	Cut Off. Front.	Cut Off. Back.	Release. Front.	Release. Back.	Closure. Front.	Closure. Back.
Full gear	3-64	3-64	5-32	⅛	1 13-16	1 15-16	27⅞	27	30¾	30 5-16	1 11-16	1¼
½ stroke	3-32	3-32	5-32	⅛	9-16	19-32	17 9-16	17 11-16	27⅝	26 11-16	5 5-16	4⅝
⅓ stroke	5-16	5-16	5-32	⅛	5-16	5-16	9⅝	10 8-16	23 13-16	23 9-16	8 7-16	8 3-16

Eccentric crank travel .... 17 15-16 ins.
Link radius .... 65 ins.
Steam lead, forward .... 3-16 ins.
Steam lead, backward .... 3-16 ins.
Steam port .... 1⅝ ins.

pin, its center being located on a line at right angles to the crank arm. The angular advance becomes zero and the link gives no lead or lap. The link oscillates about a fixed axis, and its radius is the length of the radius rod. In the construction illustrated, the end of the radius bar is connected to the link lifter arm by a slip joint. A union bar, pinned to the combination lever, extends from a short arm, which is rigidly secured to the crosshead. This lever combines the eccentric and crosshead motions, provides the angular advance, and gives the valve constant lap and lead. This motion facilitates the equalization of cut-off, and causes the irregularities of the piston motion to



PLAN VIEW OF VALVE GEAR.



WALSCHAERT VALVE GEAR APPLIED TO A LAKE SHORE LOCOMOTIVE.

and it is not believed that the exposure of the valve gear to accidental derangement when outside, by being struck by obstructions, constitutes a serious disadvantage. This gear has been used in a small way for many years in this country without difficulty, and it now appears to meet a newly developed need. It was originally developed by E. Walschaert, in Belgium, in 1844. It was applied to the Mallet compound of the Baltimore & Ohio last year, as shown on page 237 of the June, '04, number of this journal, and is in common use abroad.

The Lake Shore locomotive is similar to the New York Central 2—8—0 freignt locomotives, illustrated in this journal in January, 1904, page 16. This valve gear was selected because of its accessibility, the lightness of the parts, and the fact that it permits the use of two-bar front frames.

Walschaert gear also offers the advantage of direct pull and thrust throughout, and it should be specially advantageous for compound locomotives, where the increase of lead of the Stephenson gear necessitates providing large spaces to compress into. It is noteworthy that the four-cylinder Vauclain compounds (see American Engineer, June, 1903, page 210) require valve chambers of the same diameter as the high pressure cylinders.

CONSOLIDATION LOCOMOTIVE.—WALSCHAERT VALVE MOTION.

Lake Shore & Michigan Central Railway.

GENERAL DIMENSIONS.	
Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	223,000 lbs.
Weight on drivers	198,000 lbs.
Wheel base, driving	17 ft. 0 ins.
Wheel base, total	25 ft. 11 ins.
Wheel base, total engine and tender	60 ft. 6½ ins.
Tractive power	45,685 lbs.
CYLINDERS.	
Diameter	23 ins.
Stroke of piston	32 ins.
Diameter of piston rod	4 ins.
Kind of piston packing	cast iron rings
VALVES.	
Kind	Piston
Travel	6 ins.
Steam lap	1 in.
Exhaust lap	0 in.
WHEELS.	
Diameter of driving wheels outside of tire	63 ins.
Diameter of driving wheel centers	56 ins.
Material of driving wheel centers	Cast steel
Diameter engine truck wheels	33 ins.
Diameter and length of main driving journals	10 ins. x 12 ins.
Diameter and length of other driving journals	9½ ins. x 12 ins.
Engine truck, kind	Two-wheeled swing
Engine truck journals	6¼ ins. x 10 ins.
BOILER.	
Style	Radial stay, straight top
Outside diameter of first ring	81⅝ ins.
Working pressure	200 lbs.
Firebox, length	106 ins.
Firebox, width	76 ins.
Firebox plates, thickness	Sides, ⅜ ins.; back, ⅜ ins.; crown, ⅜ ins.; tube sheet, 9-16 ins.
Firebox, water space—side, back and front	4½ ins.
Tubes, number	460
Tubes, diameter	2 ins.
Tubes, length	15 ft. 6 ins.
Tubes, gauge	11, B. W. G.
Heating surface, tubes	3,709.42 sq. ft.
Heating surface, firebox	182.5 sq. ft.
Heating surface, arch tubes	30. sq. ft.
Heating surface, total	3,921.92 sq. ft.
Grate, area	54.9 sq. ft.
Grate, style	Rocking
Exhaust pipes	Single
Smoke stack, top above rail	14 ft. 9¾ ins.
TENDER.	
Style	Water bottom
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. x 10 ins.
Tender frame	10-in. channel
Water capacity	7,500 gals.
Coal capacity	12 tons

In the matter of weight of parts, the details, in pairs, of the Walschaert gear of this engine are as follows: Crosshead arms, 60 lbs.; vibrating rods, 220 lbs.; eccentric rods, 220 lbs.; links, 260 lbs.; transmission bars, 140 lbs.; valve rods, 70 lbs.; eccentric cranks, 100 lbs.; vibrating links, 70 lbs.; valve stems, 72 lbs., and transmission bar hangers, 72 lbs. This means a total weight of 1,252 lbs. for the entire valve gear of the Lake Shore engine, not including the valves. The weight of the corresponding valve gear parts of a recently constructed 20 x 28-in., 4—6—0 engine, with Stephenson link motion, is 2,734 lbs Such a weight, which must be moved and reversed for every revolution, imposes severe duty upon the eccentrics, and it is not surprising that they heat.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

Paris.

Friends, take the advice of one who knows, and do not attempt to jump on a railroad train at a gladly forgotten station on the edge of France after the train has started. It is only by virtue of being the editor of this journal that I am not now languishing in a dungeon in some old Bastille in this sunny land. I had a ticket, but arrived late and had lots of hand baggage. The train had just started for a 60-mile run without a stop. The door of the coach was closed, but I got it open and fell in. Fell is just the word, because I landed in the arms of the guard, who might himself have been imprisoned for my offense. He was immediately reinforced by a large bunch of French soldiers, with whom the trains are always more or less filled. I was seized by many hands and dragged into the dim light of a compartment and then the jabbering began. Their part was in French and mine in English. I had my ticket and waved it, but ineffectually. It was evident that a commandment had been broken and something was to be done with me. The years of study of French at school were too long ago to accomplish anything against these odds and so volleys of good American were fired with precision and vigor. It did no good whatever, but an inspiration led me to produce a copy of the American Engineer from the luggage and this won the day. Not knowing what might be in store for me, it seemed necessary to escape the railroad premises very hurriedly in the small hours of the morning when the next station was reached, which fortunately was where I wanted to go. Now it seems very funny, and the joke is too good to keep, but let me seriously advise all travelers to take a copy of the American Engineer with them. It surely had a wonderful effect on those cheerful Frenchmen. It moved and impressed them; they let the villain go and I lost the opportunity to scratch my initials on cold French prison walls. I ought to have been arrested, and so ought everybody who jumps on to a moving train—unless he "has to."

When in England, riding on a well-known railroad, the train had started and a great commotion occurred in the compartment next to mine. A man had dared to get on when the train was in motion. He had tried to get on once and was foiled by the guard. He tried again and was successful, only to be pulled out of the compartment by the legs. He was then surrounded and taken off to the police station for breaking the law. Next day the papers had a full account of the struggle and notice of the trial. It did not seem to occur to any one that it might be dangerous to pull a man off a moving train after he had safely got on. In traveling in Europe it is well to arrive at your station at least three-quarters of an hour before the train leaves in order to avoid these little difficulties.

These experiences, however, explain why so few passengers are injured on English and Continental railways. Regulations are provided and they must be obeyed, by all—as a rule.

Railroads are taken very seriously in Europe. Nothing there is done to-day and undone to-morrow. Progress is slow, yet there is progress. The equipment is kept up in the best of condition. Signals are everywhere. Travelers are protected against faults of others and faults of their own. No trespassing, whatever, is permitted. Much fault may be found with methods, but no price is too high to be paid for safety. Our own railroads will avoid future Government interference if they will study this lesson in time.

I found several foreign locomotive men surprisingly well informed upon American practice. One of them in England referred to recent American locomotives, stating sizes of cylinders, heating surfaces, weights and other details, indicating a close study of our progress. In Mulhouse I found Mr. de Glehn studying our practice by having his draftsmen reproduce in working drawings various details which appear in American journals, in order to ascertain whether or not ideas obtained from them could be adapted to his practice. Nothing

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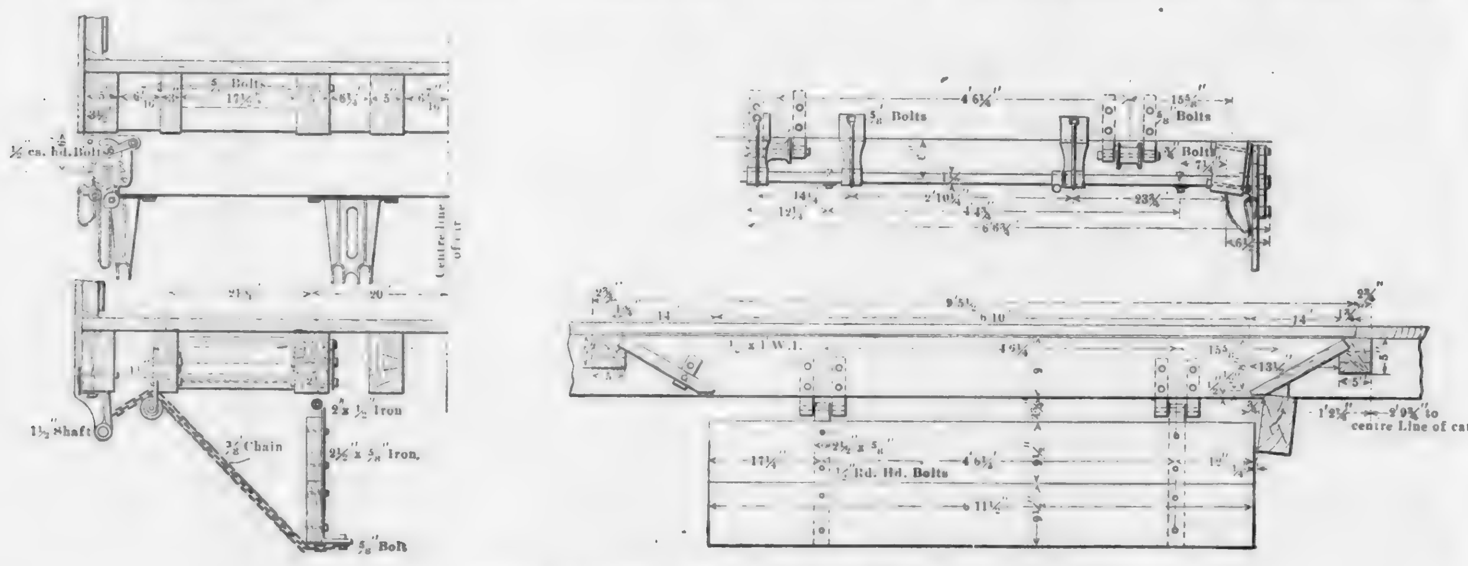
The sectional drawing shows the arrangement and sizes of the sills, truss rods and the construction of the hoppers, which are placed between the intermediate sills, with sloping ends and closed by substantial doors, held by chains. An inside door fits the opening in the floor, giving a continuous flush floor over the hoppers when the loading is other than coal. These doors are removable and are secured to the side of the car above the girts and held by buttons when coal is to be loaded.



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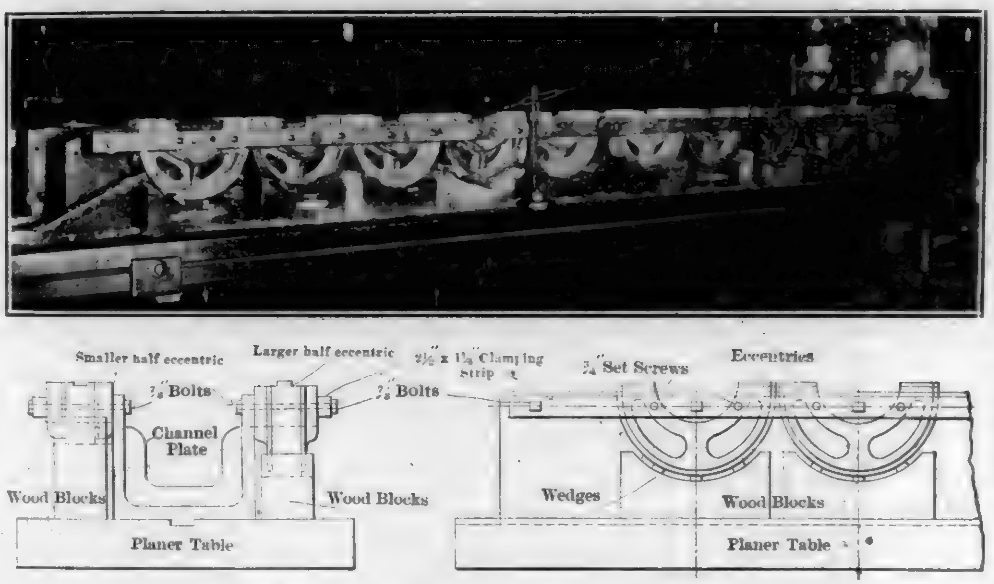

METHOD OF CLAMPING ECCENTRICS ON PLANER.

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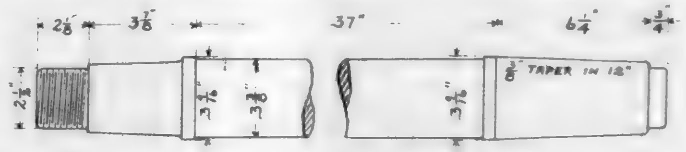

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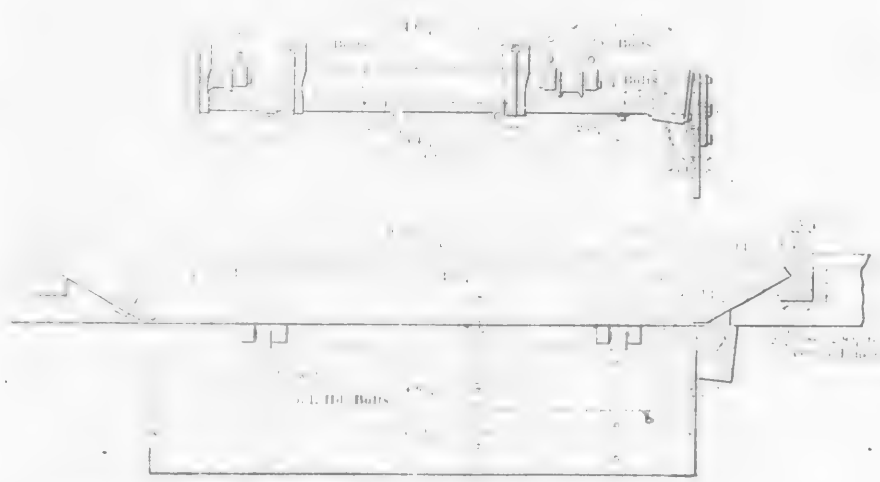

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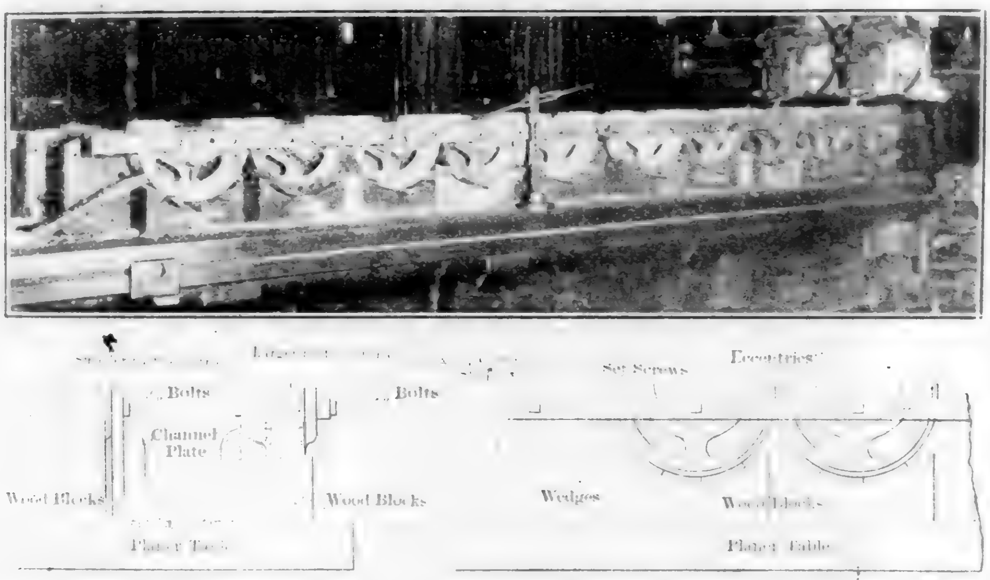

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WATER SOFTENING.

CONTROL AND RESULTS FROM A CHEMICAL STANDPOINT.

BY G. M. CAMPBELL, P. & L. E. R. R.

(*Continued from Page 17.*)

With the equipment on hand, the attendant must be instructed as to how to use it. A set of instructions properly framed is therefore supplied and hung up at a convenient point near the cabinet. Instructions for Whitsett Junction are shown in Table 1. The wording may not be the best, but the endeavor was to make the language such that any ordinary workman could fully appreciate and understand it. These printed instructions are, of course, supplemented by verbal ones with any new attendant. After the attendant has made his tests according to the rules just laid down, the next step is the charging of the chemicals and the general operation of the machine. Instructions for this purpose are supplied; those for Whitsett Junction are given in Table 2.

The exact amount of soda and lime required is given in framed tables. The soda table in use at Williamsburg is shown in Table 3, and the lime table in use at Pittsburgh is shown in Table 4. In the Kennicott machine proportionate soda treatment is taken care of by altering the amount of the solution of saturated lime water used; this latter is accomplished by varying the size of the opening in the pipe admitting water to the lime chamber. Fluctuation in the pumping rate, and the consequent required change in amount of chemicals used, is taken care of by the well-known principle of the lift pipes operated by a float in the raw water box; the head over all openings remains equal. The proportioning of the chemicals is thus independent of the rate of pumping.

THE PITTSBURGH & LAKE ERIE RAILROAD COMPANY

REPORT OF Pittsburgh WATER SOFTENING PLANT

For week ending 11-26 1904.

DAY	Pumping: Started	Stopped	Hours Pumped	Gallons Pumped	Raw Water: Hardness	Acidity with Red Indic.	Acidity with Clear Indic.	Charges: Soda: Pounds	Time of Charge	Lime: Pounds	Time of Charge	Coagulant: Copperas Pounds	Alum Pounds	Time of Charge	Treated Water: Hardness	Alkalinity with Red Indic.	Causticity	Time of Test
Sunday	8:00 A	1:20 P	5:20	80,000														
	6:20 P	8:10 P	1:50	27,500	23	0.5	10.5	184½	10:30 A	53	10:30 A				5.0	5.5	6.0	10:00 A
Monday	7:30 A	11:10 A	3:40	55,000														
	3:30 P	6:05 P	2:35	38,750	24	0.6	9.5	203	8:45 A	60½	8:45 A				5.5	4.5	4.5	10:00 A
Tuesday	7:30 A	1:15 P	5:45	86,250				216	8:30 A	49½	8:30 A							
	4:50 P	8:10 P	3:20	50,000	24	0.5	8.5	216	6:05 P	49½	6:05 P				5.0	5.0	5.0	10:00 A
Wednesday	7:45 A	1:00 P	5:15	78,750														
	5:15 P	9:30 P	4:15	63,750	24	0.6	9.0	216	11:45 A	49½	11:45 A				6.0	5.5	5.5	10:00 A
	2:00 A	3:20 A	1:20	20,000														
Thursday	7:45 A	11:00 A	3:15	48,750														
	4:20 P	6:55 P	2:35	38,750	24	0.7	10.5	216	8:15 A	49½	8:15 A				6.0	5.5	6.0	10:00 A
Friday	7:30 A	12:20 P	4:50	72,500														
	5:45 P	6:40 P	2:55	43,750	24	0.6	10.	216	8:30 A	58	8:30 A				6.0	6.0	6.0	10:00 A
Saturday	7:30 A	2:30 P	7:00	105,000				216	7:30 A	55	7:30 A							
	3:30 P	4:50 P	1:20	20,000	24	0.9	10.	216	1:30 P	55	1:30 P				5.5	5.5	5.5	10:00 A
Weekly Totals			55:15	828,750	24	0.6	9.7	1899½		479½								
Daily Averages																		
Amount of Soda and Lime used per 1,000 gallons pumped								2.294		0.578								

Stock on hand: Soda 2½ bags Lime. [illegible] bbls Copperas 2 BBLS lbs. Alum. 1½ BBLS 6 SACKS

Supplies required.

Remarks.

Mail copy of this report to Supt. M. & W. S., Pittsburgh, every Monday morning. Keep copy for yourself.

Geo. Edmunds. Attendant.

FIG. 1—WEEKLY REPORT SHEET.

THE PITTSBURGH & LAKE ERIE RAILROAD CO.

DAILY REPORT FROM

Groveton WATER SOFTENER.

Date, 11-22-'04

RAW WATER (Sample taken from Raw Water Box):

TIME OF TEST	HARDNESS	ALKALINITY (Red Indicator)	ACIDITY (Clear Indicator)
7:30 AM	13	4	2
3:30 PM	13	4	2

TREATED WATER (Sample taken from Storage Tank):

TIME OF TEST	HARDNESS	ALKALINITY (Red Indicator)	CAUSTICITY (Clear Indicator)
7:30 AM	5	6½	7
3:30 PM	5½	6½	7

TREATED WATER (Sample taken from Soft Water Box):

TIME OF TEST	HARDNESS	ALKALINITY (Red Indicator)	CAUSTICITY (Clear Indicator)
7:30 AM	4½	6½	7
3:30 PM	5	6½	6½

DEPTH OF WATER:

TIME OF READING	OVER RAW WATER SLOT	OVER SOFT WATER SLOT	OVER SODA SLOT
10:00 AM	14½"	15"	15"

NOTES.—Two samples are to be tested from Soft Water Box.
Tests of the Raw water and of the Treated water from the Storage Tank are to be those made for the weekly report sheet.
Depth of water to be measured once each day.

REMARKS: No. 2 soda tank lasted till 4:30 P.M.

M. L. Ralph.

NOTE.—This Daily Report Sheet is to be used when called for. Send original, each day to G. M. CAMPBELL, Pittsburgh, Pa.

FIG. 2—DAILY REPORT SHEET.

The attendant has, it is assumed, made his tests and run in his charges. If the treated water is not of a proper quality the fault is not his, provided, of course, the machine is in good mechanical condition and he has followed instructions in testing and charging. He, however, tests the treated water for record purposes. If this was the limit of control over the softeners, water softening would without doubt be a failure, except at such points where a thoroughly reliable and efficient man was in charge. Means for checking results have to be provided. The first check is in weekly reports, which are forwarded to headquarters. A sample report, that for Pittsburg for the week ending November 26th, 1904, is given in Fig. 1,

FIG. 3—TRAVELING CASES FOR DISTILLED WATER, TESTING OUTFIT AND SAMPLES OF WATER.

size of sheet being 8 x 10½ ins. This report is a record of all tests made, chemicals used, water pumped, etc. The amount of chemicals shipped to the softener is kept account of, and the amount stated to have been used can be easily checked up; there is also a definite relation btween the number of gallons pumped and the length of time the soda charge lasts—this relation is found experimentally for each softener, and any error in reporting can be detected, especially at points where meters are installed.

In addition to this weekly report, the attendant sends in a daily report, so that if anything goes wrong at the softener, such as the clogging up of feed pipes, wrong adjustment of lift pipes, etc., it can be noted within 24 hours, and corrected. Sample report, that from Groveton for November 22d, 1904, is shown in Fig. 2, size of sheet being 5¼ x 8 ins. This report shows whether the softener is working uniformly—that is, there should be nearly uniformity between samples from soft water box, which contains water just after passing through

TABLE 1.

PITTSBURGH & LAKE ERIE RAILROAD COMPANY.

WHITSETT JUNCTION WATER SOFTENER.

TESTING.

Bottles.—Use the square 8-ounce bottle for Hardness and the round 4-ounce for Alkalinity (or Acidity to Red Indicator), and the 8-ounce round ones for Acidity and Causticity. Always use the same bottle for the same purpose. Always thoroughly rinse out the graduated cylinder or bottle before using it with the same kind of water as you are going to test.

Indicators.—The Red Indicator is for testing for Alkalinity and Acidity, and the Clear Indicator for Acidity and Causticity.

Raw Water.—Get sample from raw water box. Test it before the addition of every lime or soda charge. For the soda charge, test for both Hardness and Alkalinity or Acidity to Red Indicator. For the lime charge test for Alkalinity (or Acidity to Red Indicator) and Acidity.

Treated Water.—Take sample morning and afternoon each day from the special tap in the discharge line from the tank and test for Hardness, Alkalinity and Causticity. Add result to weekly report sheet.

Alkalinity.—Measure 100 C. C. of the water and put into the proper bottle and add 3 or 4 drops of the Red Indicator; water will then be slightly yellow if it is Alkaline. If it is red there is no Alkalinity. Fill up the Acid burette to the zero mark, then run this into the water a few C. C. at a time at first, and one or two small divisions toward the end, shaking the bottle a little. As soon as the water remains a very light red color after shaking, the test is finished. The number of C. C. of solution used is the Alkalinity.

Acidity to Red Indicator (make this test only when there is no Alkalinity).—Measure 100 C. C. of the water and add to proper bottle; add 3 or 4 drops of Red Indicator, water will then be orange color or red. Fill up the Soda burette to the zero mark and run this slowly into the water till the color just changes to yellow after shaking; the test is then finished. The number of C. C. of solution used is the Acidity to red indicator. Put this result in the Alkalinity column of report and mark "Acid" after it.

Acidity to Clear Indicator.—Measure 200 C. C. of the water to be tested, add to proper bottle and add 5 or 6 drops of the Clear Indicator. If the water turns at once and remains a pink color, there is no Acidity. Fill up the Soda burette to the zero mark, then run this into the water one or two C. C. at a time, and shake bottle. As soon as a faint pink color remains after shakng, test is finished. The number of C. C. of solution used is the Acidity.

Causticity.—Measure 200 C. C. of treated water, and put into proper bottle. Add 3 or 4 drops of Clear Indicator. Water will usually turn pink. Fill Acid burette to zero mark and run in a few C. C. at first and toward the end ½ C. C. at a time, until the color disappears. The number of C. C. used is the Causticity.

Hardness.—Measure 100 C. C. of the water to be tested and put into the proper bottle. Fill the soap burette to the zero mark, then run this into the water to be tested, 1 C. C. at a time until there is nearly enough in, then only one or two small divisions at a time. Shake bottle vigorously after each addition of soap solution. Note lather carefully: if it disappears, add more soap, until you get the lather to hold for 3 minutes, with the bottle lying on its side. The number of C. C. of solution used is the Hardness. If Hardness of raw water is greater than 12, then take only 50 C. C. of raw water and add to it 50 C. C. of distilled water. Multiply the number of C. C. of solution used by 2 to get the Hardness. Note: if water is acid to Red Indicator before testing for Hardness add C. C. of Soda solution equal to the Acidity. G. M. CAMPBELL.

Pittsburgh, November 30, 1904.

TABLE 3.

PITTSBURGH & LAKE ERIE RAILROAD COMPANY.

WILLIAMSBURG WATER SOFTENER.

SODA TABLE.

December 2, 1904.

Hardness less Alkalinity or Hardness plus Acidity. (Red Indicator Only). Degrees.	Soda. Pounds per Charge.
1	6
2	12
3	18
4	24
5	30
6	36
7	42
8	48
9	54
10	60
11	66
12	72
13	78
14	84
15	90
16	96
17	102
18	108
19	114
20	120
21	126
22	132
23	138
24	144
25	150
26	156
27	162
28	168
29	174
30	180

The Acidity in the table is the Acidity to Red Indicator only.

This charge should treat about 60,000 gallons of water and should last about 6 hours, but the time may vary from 5 to 7 hours according to rate of pumping. G. M. CAMPBELL.

TABLE 2.

PITTSBURGH & LAKE ERIE RAILROAD COMPANY.

WHITSETT JUNCTION WATER SOFTENER.

TESTING.

Examine slots in raw water box, soft water lift pipe and soda lift pipe to see that they are unobstructed. Examine all valves to see that they are working properly, especially Soda float valve.

DUMPING.

Main Tank.—Dump the main tank below top of top filter plate each morning before starting to pump, and every six hours the machine is in operation during the day.

Lime Saturator.—Dump Lime Saturator every Saturday. This is done to get rid of stones and undissolved lime. No exact time can be given for this—the attendant will have to tell from experience just how long to hold valve open, usually 10 to 20 seconds will do.

CHARGES.

Soda.—Test Raw Water just before it is time to turn tank into service. Take the difference between Hardness and Alkalinity or the sum of Hardness and the Acidity to Red Indicator, then add to the tank sufficient Soda to make the total amount in the tank whatever the table calls for. Most of the charge should have been in for several hours. Immediately after a tank has been emptied, fill it with water and put into it, through the wire basket, about 12 pounds less than total amount of Soda in the other tank and thoroughly stir, the balance to be put in according to test at time tank is turned into service. For example, suppose No. 1 tank has a full charge of 45 pounds of Soda and is turned into service, No. 2 is at once filled and given a charge of 33 pounds. When No. 1 is nearly empty test water and consult table. Suppose 49 pounds are required; as 33 are already in, it will be necessary to add only 16 to bring total to 49. When charging No. 1 you would start it with 37 and so on. Enter on the report the total pounds in the tank and the time you made the test just before turning tank in. After a tank has been turned into service do not add any more Soda, even though Raw Water may have changed. Use it up just as it stands.

Lime.—Test the water for Alkalinity or Acidity with the Red Indicator and for Acidity with the Clear Indicator. Take the Acidity with Clear Indicator and add to it the Alkalinity or subtract from it the Aicidity with Red Indicator, according to which ever is present, and from the table find out the amount of lime required; mix up in the Lime Slaking Box the amount of lime called for by table. This should be done long enough before lime charge is required to get it into a soft paste. At the proper time run the whole charge into Lime Saturator, do this slowly—take 10 or 12 minutes—otherwise pipe might get clogged at bottom; use as small an amount of water as possible. Adjust the Lime slot carefully, according to table, as called for by the test. Always adjust slot after making a test, even though a lime charge is not due.

SAMPLES.

Always thoroughly rinse out the cup or bottle in which sample is taken. Raw Water should be taken from the Raw Water Box after the pump has been running for at least ten minutes.

Treated Water should be taken from the special tap in the discharge line from the tank.

Samples to be sent to Pittsburgh of the raw and treated waters should be collected at the time of making the first test on Monday, Wednesday and Friday—raw water in the dark bottles and treated water in the clear bottles. Be careful to put the bottles in the right compartment in the box. G. M. CAMPBELL.

Pittsburgh, November 30, 1904.

TABLE 4.

PITTSBURGH & LAKE ERIE RAILROAD COMPANY.

PITTSBURG WATER SOFTENER.

LIME TABLE.

December 2, 1904.

Acidity with Clear Indicator plus Alkalinity with Red Indicator or less Acidity with Red Indicator. Degrees.	Slot. No. of Degrees.	Lime. Pounds.
1	4	5
2	8	10
3	12	15
4	16	20
5	20	25
6	24	30
7	28	35
8	32	40
9	36	45
10	40	50
11	44	55
12	48	60
13	52	65
14	56	70
15	60	75
16	64	80
17	68	85
18	72	90
19	76	95
20	80	100

Run in the charge of lime at the same time the soda tank is turned into service; this will be about every 6 hours, but the time may vary from 5 to 7 hours according to rate of pumping.

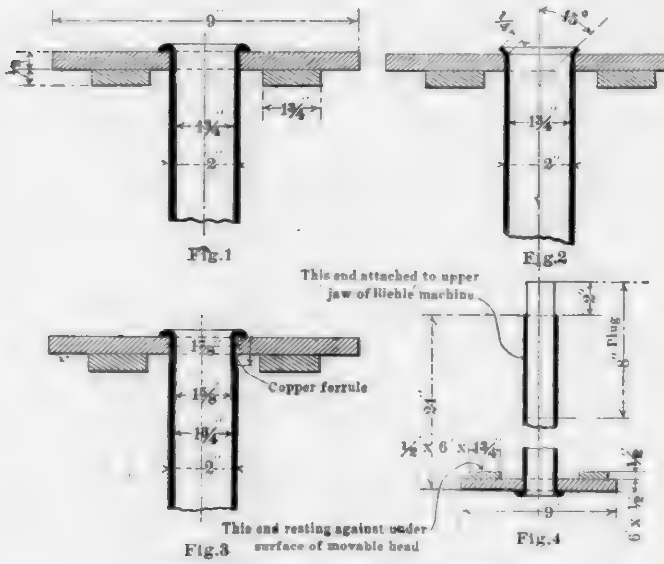
G. M. CAMPBELL.

the softener, and there should also be agreement between the water from soft water box and that from storage tank, though on account of the capacity of the storage tank, a time element enters so that, for example, water that passes through softener one day might not leave storage tank till two days later. On this report, the depth of water over slots is given—first, to show whether all lift pipe attachments are correct, and, second, to show rate of pumping; the rate for various depths of water is determined by experiment. As a check to prevent any falsification of records, samples of raw water and of treated water are collected at the time of the first test on Monday, Wednesday and Friday; raw water is collected in amber-colored bottles, treated water in clear. These bottles, 30-oz. metal-stoppered, are kept in a small shipping case, shown at right-hand side in Fig. 3. Each bottle has its own compartment, so that no labeling of samples is required. On Friday, when all the bottles are full, the case is locked and shipped to Pittsburgh, where the samples are tested. A duplicate case has in the meantime been sent to the softener, so that the attendant is always in possession of a full set of bottles. The card in the holder has the Pittsburgh address on one side and the softener address on the other; the proper return of all cases is thereby assured.

(To be continued.)

SECURING ARCH TUBES IN FIREBOXES.

While the construction often necessitates the use of a particular method of securing the arch tubes in the tube sheet, yet even when it is possible to get at the end of the tube through a hole in the throat sheet there is considerable difference of opinion as to the best method of securing it. A prominent railroad recently made a series of laboratory tests to determine the best method. The results were very conclusive. Tubes secured as shown in Figs. 1 to 3 were pulled in a Riehle testing machine. The tests do not exactly represent practice, because the steel plates into which the tubes were secured bore against two bars of ½-in. plate, placed close to the tubes. This, however, is not believed to materially



SECURING ARCH TUBES IN FIREBOXES.

affect the results. The practice of this road is to roll the arch tubes to the sheets and expand them, as shown in Fig. 2, leaving a projection of ½ in. after expanding. This form removes the end of the tube from the hot sheet, and it has been found satisfactory in service.

An average of three tests of the arrangement shown in Fig. 2 showed a holding power of 27,140 lbs., as against 24,055 lbs. for Fig. 1 and 19,470 for Fig. 3. This would indicate a marked superiority of the form represented by Fig. 2.

	No. of Tests.	Holding Power, lbs. Max.	Min.	Mean.	Remarks.
Fig. 1..	6	25,830	20,830	24,055	Rolled to sheet and beaded.
Fig. 2..	3	28,730	23,960	27,140	Rolled to sheet and expanded.
Fig. 3..	2	21,280	17,660	19,470	Rolled to sheet, beaded, swedged to 1⅝ in. for copper ferrules.
Fig. 3..	1	....	....	16,560	Rolled to sheet and expanded, swedged for copper ferrule.

The Steadfast Man.—The technical school is not exclusively for the brilliant man. Much of the world's best work is done by the man of slow-moving intellect, to whom the good Lord has given the greater treasure of persistence, of steadfastness, with enough of imagination to feel what is concealed within the cloud on yonder difficult and distant hill.—*John C. Freeman.*

CARE OF SMALL TOOLS.

To the Editor:

With growing complexity of modern railroad business the question of system in the handling of tools becomes an important and increasingly difficult one. Superintendents of shops, master mechanics and foremen will generally, when asked, admit that the problem does not permit of ready solution and that they have much difficulty in arriving at satisfactory results. They will say that without a large clerical force and impracticable red tape no reliable record of tools supplied to men can be kept, that the *detailed* cost account of expenditures for tools is not ascertainable, that it is not practical on the whole to compel the return of tools to the tool room or to tell at all times what tools are on hand, whether these meet the actual requirements, what requisitions should be made to actually cover the needs of the work; nevertheless all of these men will recognize the desirability of some such system and will have at various times in their work attempted to establish something of this kind—oftentimes with considerable measure of success. If questioned still further they will recognize that only by eternal vigilance can a helpful system, once established, be maintained. This vigilance is usually too wearing on the master mechanic or other official in charge to enable him to carry it out unless he happens to have an excellent man looking after the tool question—and railroad companies do not as a rule offer sufficient inducement to this kind of man in such capacity.

But this whole problem, and really in a much more difficult form, has been worked out thoroughly and satisfactorily already. Libraries, large and small, are confronted with the same task of caring for a multitude of objects (books—intellectual tools we may call them) of varying value and usefulness; these are kept in a central store room, and are accessible at all times to those requiring them. They are to be allotted to these individuals, a record must be kept of each withdrawal, and a prompt return of these objects out an undue length of time compelled; they must be kept at all times ready for efficient use—that is, well repaired in case of damage—and replaced if worn out.

The parallel between a library and the tool equipment in a shop goes as far even as the value of the individual books and tools, the average cost of each of which may be taken at approximately $1; cape chisels might correspond to magazines, expensive art folios to pneumatic tools. But in this respect the library has the harder proposition. It deals with an irresponsible public, whereas the shop deals with men subject to discipline, even to financial indemnity, from pay-checks held back, in case of abuse of property. The number of the individuals and objects dealt with in the two cases is also much greater in the library than in the shop. The library, however, is run smoothly and its business transacted expeditiously—can the same be said of our railroad shop tool rooms?

Certain of our larger manufacturing enterprises (Westinghouse Electric Company, General Electric Company, National Cash Register Company, R. Hoe & Company, Link Belt Manufacturing Company, etc.—the list grows daily) have tackled the problem vigorously and are meeting with the success that the same methods have won in library practice, although methods evolved, we believe, independently; and following in the wake of these successful examples in the commercial world, some of our more important railroads have made determined efforts in the same direction, the Union Pacific, Santa Fe, and Northwestern line being examples. That is, these roads have found that it pays well to organize their shop tool system in a comprehensive and intelligent way, instead of leaving the problem to chance and individual caprice.

There is a branch, and an important branch, of this tool proposition which is peculiar to the railroad, namely that of equipping locomotives with tools. This phase of the problem is a serious

one, for often the presence on a locomotive of some tool or device (for example, eccentric set screw wrench, or valve stem clamp) will greatly lessen a delay. In some cases even an engine may be enabled to get home if the engineer has tools to work with instead of waiting to be towed. Few railroads, however, handle this matter in a consistent or helpful manner. The Union Pacific has good practice, the N. Y. Central and the Pittsburgh & Lake Erie, the Erie also good, and among small roads the Buffalo, Rochester & Pittsburgh may be mentioned as fully alive to, and in control of the situation. This question was not as important 20 years ago, just as small tools in the shop were not a problem, for in those days each mechanic possessed his own tools and cared for them, each engineer operated *his* particular engine and the equipment in each case was kept up by the man's pride and interest in his own work. With the coming of the large shop of modern days and with the advent of pooled engines operated day and night, the problem has developed to serious proportions; it is the change from the private library or personal corner book shelf to the public institution supplying, not only each man's needs, but all mens' needs.

On locomotives we have really the same problem as in the shop, that of giving out to individual certain tools and requiring care of the same, only in the one case we are dealing with the irresponsible locomotive and in the other with men whose attention we can compel. We must, therefore, make the engineer responsible for what belongs to his ward—the locomotive.

We can arrive at this in a practical manner by some such arrangement as follows:

1. Divide the tools into four groups: emergency tools, heavy tools, portable tools and engineer's equipment. 2. Emergency tools, comprising wrecking frogs, chain, spare brasses, fuses, etc., can be placed under seal. Inspection of the seal at roundhouses will determine whether the equipment has been tampered with, and if used the engineer must furnish report. 3. Heavy tools, such as fire hooks, push bars, journal box jacks, are not likely to be disturbed and may be left loose on the engine. 4. Portable tools should be kept under strong lock, preferably in iron boxes and these boxes either turned in to a common tool room on arrival at the roundhouse where they are inspected and missing tools accounted for, or left on the engine and there inspected. In this connection it should be noted that the ordinary padlock and hasp and staple are almost no protection against forcible opening of the boxes; a good Yale or Corbin lock with the staples *bolted* to the tool box are recommended for substantial and safe construction. 5. Engineer's tools consisting of torches, oil-cans, and possibly Stillson wrench may be taken care of by the engineer himself and kept in his own cupboard when not on the road. This method will encourage the engineer to be saving of his oil, although many railroads have other systems in connection with giving out and return of oil.

Let it be remembered that not only will economy of tool equipment result from the establishment of a thorough engine tool system, but also the tools will be on the engine when they are wanted, returning to the company many times the cost of both the tools and the system in the avoidance of vexatious delays and inconvenience to traffic. It is time that this important detail of practical railroad management receives the serious consideration of our large railroads.

"ONE WHO HAS DONE IT."

LOST MOTION IN LOCOMOTIVE SERVICE.

To the Editor:

In discussing the time service of locomotives the *Railway Age* of November 18 refers to the desirability of studying actual records in order to understand the delays as a means of reducing the time engines are idle. Interesting figures are given in the following quotations:

"Where such records have been obtained from special tests during a period of one month the following distribution of time covering the proportion laid up, in operation, and delays, was obtained for 3,000 miles in freight service, and a total of 715 hours: The total time in hands of motive power department at the roundhouse was 143 hours, or 20 per cent., delays on road due to motive power, such as engines not steaming, hot boxes, defective brakes, drawbars, etc., 14 hours, or 2 per cent., running time hauling train, 200 hours, or 28 per cent.; time in hands of transportation department when not making mileage, 357.5 hours, or 50 per cent. As the result of this large proportion of lost time and delays on road, the average running time was 15 miles per hour, the average equivalent speed for transportation, 5.2 miles per hour, and average equivalent for total time of test, 4.2 miles per hour. Results nearly similar to these were obtained from other divisions of the road with heavy traffic, where it was supposed that the motive power department was not furnishing sufficient power and was holding engines too long at roundhouses. By the time record as given above it was easily shown that the transportation department was responsible for much the larger part of the delays and for the low average speed obtained for transportation."

This interesting exhibit shows that the lost motion when in the hands of the transportation department amounts to exactly the total time in the hands of the motive power department plus that due to engine failures and delays because of hot boxes defective brakes and broken drawbars, plus the time consumed in actually hauling trains. This statement may be put into convenient form for railroad men to paste in their hats, as follows:

Period	1 month
Mileage	3,000
Hours	715
Days of 24 hours	29

	Hours.	Per Cent.
Total hours in hands of motive power department at roundhouse	143	20
Hours delay on road for which motive power department was responsible, *i. e.*, engine not steaming, hot boxes, defective brakes, draw bars, etc.	14	2
Running time hauling trains	200	28
Dead time in hands of transportation department when not making mileage	358	50
Totals	715	100

Average running time $\frac{3000}{200} = 15$ m.p.h.

M.p.h. based on total time $\frac{3000}{715} = 4.2$ m.p.h.

M.p.h. based on total time in hands of transportation department, $\frac{3000}{358 + 200} = 5.38$ m.p.h.

L. R. POMEROY.

WHAT CAN A FIREMAN SAVE?

To the Editor:

In the editorial on page 431 of your November number you offer arguments for educating enginemen, firemen and shopmen. I see no way to secure better service except by increasing the severity of discipline until all but the very best men are weeded out. I do not see how a fireman can effect a saving that amounts to anything. What we ask of him is that he gets the train over the road. That is a matter of brute strength and does not involve education, which would prove to be an expensive luxury in the future as it has in the past.

GENERAL MANAGER.

EDITOR'S NOTE.—What can a fireman save? What does he want to save when he sees coal dumped in bulk on his tender with no attempt to measure or weigh it? What inducement has he to save fuel when his engine has an overload and he has seen a light engine and caboose pull out to go over the division directly ahead of him? Evidently there is need of education in positions far higher in rank than those referred to in the editorial. This correspondent's plea for more muscle and less education seems like a voice out of the dark ages. Locomotive service has become so exacting as to require a high degree of physical strength in firemen, but this very fact is the strongest argument for education. The man who is trained to use his brains will get over the road when brute strength alone will fail. Doesn't everybody know this?

AN IMPROVEMENT NEEDED IN TRUCKS.

To the Editor:

My position as master mechanic and my observations in years past prompt me to call attention to a weakness in railroad rolling stock which, I think, should be remedied, and by so doing large sums of money and many lives could be saved. I refer to the present construction of car trucks, swivel trucks, so called. Trucks should be and can be secured more firmly to the car body. When a car is derailed, the body and truck separate. They do so with the slightest provocation and sometimes with very serious results. About the first thing a truck does when derailed is to swing around crosswise of the track, resulting in a general smash-up of all cars following, whereas if the derailed truck or wheels had kept on in a straight line and held fast to the car body until it had spent its force, or the derailment had been discovered and the train stopped, there would have been no serious results. You will readily see the advantage of this.

MASTER MECHANIC.

(Established 1832).

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

We cordially invite our many friends attending the conventions at Manhattan Beach in June to make use of our offices. Telegrams and mail addressed in our care will receive careful attention.

The advisability of improving the attachment of trucks to car bodies, so that in case of derailment the truck cannot swing too far out of line with the rails and the truck will be securely held to the car body, is suggested by a correspondent on another page in this issue. This suggestion is important. Such construction should be simple as well as effective and if the desired result can be accomplished without too radically changing present practice, the improvement will meet a widely recognized need.

Automatic stokers are very successfully entering the forging and heating furnace field. No radical changes in the furnaces seem to be necessary, and those who are using them find no disadvantages whatever thus far. Several types of "underfeed" stokers are used and the cheapest grades of bituminous coal employed. With hand firing it is impossible to use this coal in heating furnaces without producing a distressing amount of smoke, but with the stoker there is none whatever. Even oil furnaces have been replaced by stokers in one large forging plant and the cost seems to be to the advantage of the stokers. In this installation the stoker-fired furnaces discharge directly into the atmosphere of the shop, with no chimney connection whatever, so complete is the combustion. Of course volumes of gas are poured out, but this is hot and passes at once to the roof and out of the ventilators. The stoker people appear to be slow to appreciate the field which lies before them in forge shops. It is to be hoped that figures may be obtained showing the possibilities in connection with such work as is done in large quantities in railroad shops.

ROCK ISLAND POWER COMMITTEE REPORT.

No one can dispute the statement that the greatest operating problem before railroads to-day is that of the locomotive.

Even on small roads the motive power question is assuming an importance which was entirely unknown a few years ago, and to-day the most vital portion of railroad operating statistics are those involving the records of what locomotives are doing.

As railroads are combined into systems, the questions which are important in small units become proportionately more important in aggregation of properties in which a large whole is made up of a number of parts, each with different local conditions, and the concentration of a number of independent roads into one combined organization has brought problems with which few managements have prepared themselves to deal.

The Rock Island system, in its comprehensive examination of the motive power problem in a report, abstracts of which are being published in this journal, has prepared a document of very great value, as suggesting the sort of study which every railroad should make of the condition of its locomotives. If any large system of roads, recently brought together under one management, will examine the number of different types of locomotives bought within a period of, say, five years, the number will be surprising. While standardization may easily be carried far enough to obstruct progress and improvement, provision for the future should be made whereby locomotive equipment may be added in accordance with a carefully prepared plan, constructed in the interests of reducing the number of types for which shop facilities must be provided and repair parts must be carried in stock.

The existence of such a document is as highly creditable to the railroad system, as its character is creditable to Mr. T. S. Lloyd, general superintendent of motive power, and the members of the committee. No argument is required in support of the statement that every American railroad should know the condition of its locomotives and prepare a systematic program for the future, including an investigation of possible fundamental improvements, such as are reported in this interesting document. Fifty new locomotives have already been ordered in accordance with the report.

ROUNDHOUSE EQUIPMENT AND OPERATION.

Much needs to be said about the equipment of roundhouses because of the fact that those which were up-to-date and considered examples of ideal practice only three years ago are now considered obsolete. As locomotives become bigger and as their work increases, running repairs become more and more important and there will be an increased necessity for additional facilities for prompt emergency work. For example, a new roundhouse plant is described in this issue which provides 8 drop pits, and they will be needed.

As the roundhouse becomes more important, the man to manage it properly is preparing to become general manager, because there is no intermediate position which he cannot fill. Everything goes well when the master mechanic gives his attention to the movement of engines. Here seems to be the pivot around which the whole roundhouse problem turns, and it is necessary now, and in future will be more so, for the master mechanic to give more of his attention to what may be termed the operating part of his responsibilities.

The trouble is not alone with the roundhouse foreman. It is also with the master mechanic, who on most roads is usually insufficiently supported by assistants. On seriously considering the work which a division master mechanic is required to do, a business man must condemn his situation as absurd if not impossible. The time has come for separating the shop and road responsibilities and dividing the enormous amount of detail coming before the master mechanic. For the sake of both branches the responsibilities should be separated. This is not saying that master mechanics should not have charge of shops. It may be advisable that he should have the respon-

sibility of the shops, but he should have a capable shop superintendent who can relieve him from all care of the details.

What is needed is an organization which will permit of doing $10 worth of work in the roundhouse to save $100 worth in the shops, and will permit the master mechanic to personally look after such large matters as the operation of locomotives, engine failures, the economical use of fuel and the training of the enginemen. The shop problem is entirely different from this and should be dealt with by a man who is essentially a shopman. No one man can be outside and inside the shops at the same time.

THE MISCONCEPTION OF POWER OF STEAM LOCOMOTIVES.

In discussing electric as substitutes for steam locomotives it is important to be correct as to what steam locomotives are doing. Doubtless Mr. H. Ward Leonard and *The Electrical World and Engineer* will be glad to be set right as to an error which appeared in that journal on January 7, by Mr. Leonard in an article entitled, "Why Steam Locomotives Must Be Replaced By Electric Locomotives For The Heavier Freight Service." One of Mr. Leonard's paragraphs is as follows:

"A modern compound freight locomotive, which produces about 1,400 h.p. at 18 miles per hour, with a pull at the drawbar of 30,000 lbs., can produce as a maximum about 50,000 lbs. drawbar pull, but to do so will have to reduce its speed to about, say, 3 miles per hour, and will then produce only about 400 h.p."

This does not represent the facts and is an injustice to the steam locomotive. A drawbar pull of 50,000 lbs., which could be obtained with a cylinder tractive effort of about 53,000 lbs., would, at 3 miles per hour, represent 424 h.p.

$$\frac{53{,}000 \times 3}{375} = 424$$

However, such a locomotive would have at least 4,300 sq. ft. of heating surface. The Santa Fe Decapod (see AMERICAN ENGINEER, June, 1902, page 192) has a total heating surface of 5,390 sq. ft. and could use its maximum tractive effort up to a speed of 10 miles per hour. The highest speed at which a locomotive can utilize its maximum tractive effort is represented by the formulæ $125 \frac{HS}{TE}$; applied to this case the result is $125 \times \frac{4{,}300}{53{,}000} = 10$ m.p.h., and the corresponding h.p. is $\frac{53{,}000 \times 10}{375} = 1{,}410$ h.p., or 3.5 times the amount given by Mr. Leonard.

The substitution of electric for steam locomotives will be greatly facilitated if the real facts concerning the performances of the steam locomotives are considered in comparison.

FUEL CONSUMPTION OF LOCOMOTIVES.

The paper read by Mr. G. R. Henderson, before the American Society of Mechanical Engineers, which is printed in full in this number, is an exceedingly important document on the subject of locomotive operation, and one which may be profitably studied in connection with the four articles by Mr. Henderson, which were concluded in January, page 11. This method of studying the relation between speeds, loads, and fuel consumption of locomotives is of the utmost importance to railroad officials, as it provides a convenient method of examining locomotive performances with a view of using motive power effectively. While it is impossible to get an operating official to admit that he is practicing overloading on the one hand, or running freight traffic too fast on the other hand, it is easy to find examples of both of these faults of operation, and only by such a study as Mr. Henderson's recent articles render possible and convenient may it be known whether locomotive operation is what it should be.

It is to be hoped that these articles will have the serious attention of general managers, as well as motive power officials, not only from the standpoint of economy, but also from those of excessive engine failures and capacity in handling traffic over congested districts. Mr. Henderson's diagrams are easily applied, and should exert a strong influence for improvement in a field where marked improvements are becoming essential.

EDUCATION OF RAILROAD EMPLOYEES.

The busy reader should not turn from this subject because it is old. It is newer than ever, and the present conditions of railroad operation and of the labor problem give it an importance which it never had before.

Some able writers on this subject have considered the "higher branches" of railroading as a "profession" and stand for the education of a favored class for official positions. They wish to provide "for adequate training of the men destined to lead in the upper ranks of the service by extending the existing collegiate technical courses and enlarging the curriculum, more particularly so as to embrace general questions affecting railroad traffic, transportation, finances, law, administration, etc." Incidentally they point to the discouragements surrounding the subordinate railroad worker and consider it impossible to raise these men to obtain from their class those who are to lead in the higher positions.

This quotation voices the prevailing opinion of those who have looked to the technical schools for the training of men who are needed on railroads. Undoubtedly their arguments are strong and no one need quarrel with them or with anyone who is exerting efforts of any kind toward advancement and improvement. Let this good work go on, but there is another and infinitely more important need which thus far has not been seriously studied and another problem which has not been forcefully attacked. This is the education of the men within the ranks of subordinate workers in all departments. It is these men, the lower class, who have supplied the leading and most successful officials, the men who have made American railroad practice. From this "class" will also come the best officials of the future. No arguments are necessary to support this statement.

These successful men from the ranks would be bigger, broader and even more successful if, in connection with their development, they had enjoyed privileges of education, which might easily have been given them. Others who worked beside them in the office, the shop, on the tops of freight cars, or on the tracks, who never would become leaders, would be better men had they also been provided with educational privileges.

What is needed on railroads to-day is the application of the principle developed by Mr. M. P. Higgins, of Worcester—the development of the men in the ranks as far as they can go. He says, in effect, educate a thousand good workmen. From among these may be found a number of foremen, a few subordinate officials and an occasional manager. This may be accomplished by educational work conducted by the railroads themselves, or under their immediate control. It may be approached in connection with methods of recruiting the service, and it may be carried far enough to fit those who are capable for short special courses, prepared for their needs at progressive technical schools.

We need to be reminded that many men in the ranks are sure to rise in one way or another. If they are not encouraged in every possible way to qualify for higher positions on the staff they will employ their leadership in other directions, and here is an opportunity to reach one of the roots of the labor problem which has already been allowed to wait too long.

It is well also to be reminded of the monumental failure of the Baltimore & Ohio Technical School for its employes. That school was sure, sooner or later, to fail. That attempt should not be repeated. It served not to show the difficulties and the

complications, but the simplicity of the problem. Instead of taking the student to the school, the school should be taken to the student and the needs of the telegraph operator, the section hand, the shop apprentice, the locomotive fireman, the clerk, provided for directly, inexpensively and effectively. Nothing would be gained by explaining how this may be done until the vital and general necessity for it is realized and understood. It may be done, and well done, by any railroad, large or small, the officers of which are prepared to make the effort. Heads of departments must work in hearty conjunction with the "school teacher," and the results will depend entirely upon the strong support and goodwill of the highest officials of the road. Only where this conjunction and support by the heads of departments and the highest officials are given to an educational movement has it the least chance to succeed. The first education required is that of the officials and owners of railroads.

American railroads would do well to study the educational development of 40 years by the British Admiralty. There is no harm in improving technical school training for railroad service, but a greater work lies nearer at hand and constitutes a far more vital need to-day—the education of the workers. This accomplished, the part to be played by the technical schools becomes easy and simplified, because the students know what they want and are prepared.

It is said that "school teaching is not the business of a railroad." When heard for the first time, this sounds like a conclusive statement of fact, and seems to settle the whole matter But it does not settle it. The railroad is the school of its own recruits and always will be, whether the recruits are apprentices or college graduates, sons of workmen or sons of the directors, and because a large majority never complete grade school studies some one must take them in hand. The railroads need *educated men* (for example: to fire a 100-ton locomotive).

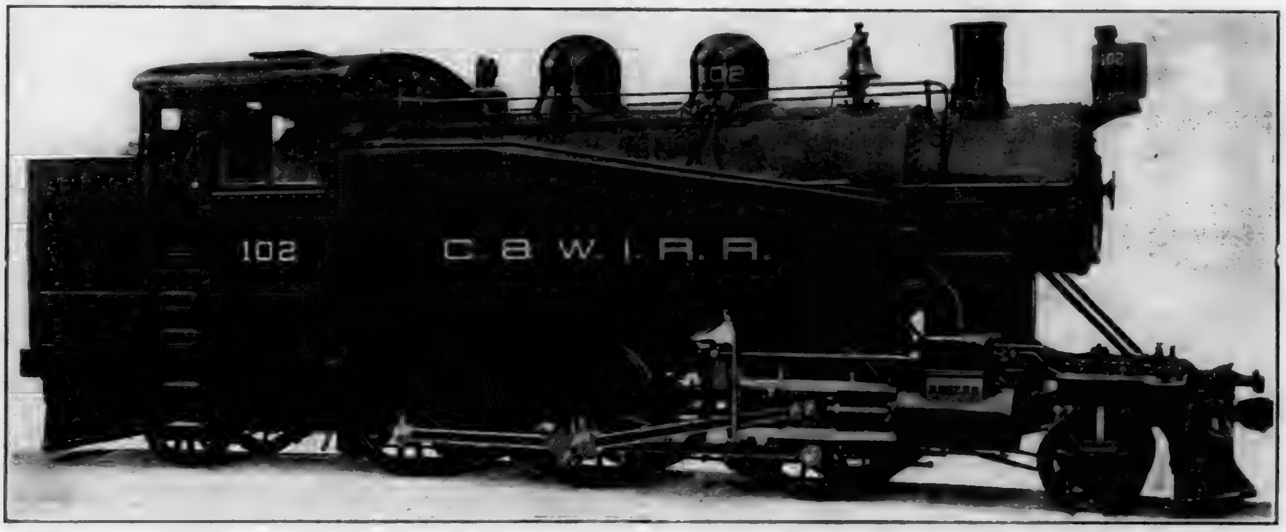
As long as the education of a class of men to become railroad officials is considered the vital question, the real problem will always remain; but when the education of the rank and file is provided the special preparation of officials will take care of itself.

Boston Tunnel Opened.—On December 30 the tunnel to East Boston was opened for traffic and is now used regularly by the Boston Elevated Railway. The harbor section is 2,700 ft. long and the depth of the earth between the top of the tunnel and the harbor is about 20 ft. When the harbor is dredged to 40 ft. the depth of earth will be about 5 ft. The leakage of the harbor section is only 8 gallons a minute, as compared with 8,000 gallons of the Mersey tunnel in Liverpool.

SIX COUPLED SUBURBAN LOCOMOTIVE.

2—6—2 Type—Chicago & Western Indiana R. R.

The Rogers Locomotive Works have built a number of locomotives for suburban service on the Chicago & Western Indiana Railroad in Chicago. They have side tanks, and in both appearance and arrangement resemble locomotives for similar service on the Central Railroad of New Jersey (American Engineer, June, 1902, page 200). For convenience in keeping a record of recent suburban locomotives, the leading dimensions of three other typical designs are presented in the accompanying table. The appearance of the Rogers design is greatly improved by placing the headlight in front of the boiler. These engines are adapted for running in either direction. They have moderately wide fireboxes. An increase of 500 gals. in tank capacity above that of the Philadelphia & Reading and the Central Railroad of New Jersey designs is obtained by placing a supplemental tank under the cab, which brings the capacity up to 3,500 gals. The tanks are connected by pipes shown in the engraving. The coal capacity is 5 tons.



SUBURBAN LOCOMOTIVE, CHICAGO & WESTERN INDIANA RAILROAD.—ROGERS LOCOMOTIVE WORKS, *Builders*.

The boiler has a straight top, with radial stays. The trailing wheels are 42 ins. in diameter, and the trailing axles have 8 by 13½-in. journals. The tractive power of this engine is exactly the same as that of the Central of New Jersey, 22,700 lbs.

FOUR TYPICAL SUBURBAN LOCOMOTIVES.

Name of railroad	N. Y. C.	C. R. R. of N. J.	P. & R.	C. & W. I.
Road number	1410	200	381	102
Builder	American	Baldwin	Baldwin	Rogers
Type	Simple	Simple	Simple	Simple
When built	1902	1902	1903	1905
Weight, total	216,000	189,900	201,700	190,000
Weight on drivers	128,000	129,000	120,860	130,000
Weight, leading truck	......	21,900	19,120	20,000
Weight, trailing truck	......	39,000	61,920	40,000
Wheel base, driving	15-0	14-0	12-6	14-0
Wheel base, total	35-9	31-8	30-9	31-2
Driving wheels	63	63	61⅝	63
Cylinders, diameter	20	18	20	18
Cylinders, stroke	24	26	24	26
Heating surface, firebox	162	96.6	156.3	146.5
Heating surface, arch tubes	......	43.0	......	......
Heating surface, tubes	2,275	1,695.0	1,825.5	1,694.9
Heating surface, total	2,437	1,834.6	1,981.8	1,841.4
Firebox, length	93	109	94	102
Firebox, width	97⅞	72	105	66
Grate area, sq. ft.	62.1	54.5	68.5	46.8
Boiler, smallest diameter	70	60	66	60
Tubes, No. and diameter	365-2	249-2	447-0	249-2
Tubes, length	12-0	13-0	9-0	13-0
Steam pressure	200	200	200	200
Reference in American Engineer and Railroad Journal	April, 1902 P. 115	June, 1902 P. 200	Oct., 1903 P. 364	Feb., 1905

Rivets in a Steamship.—It is stated that 1,800,000 rivets, weighing 600 tons, were required in the construction of the new Cunard liner *Caronia*.

FUEL CONSUMPTION OF LOCOMOTIVES.*

BY G. R. HENDERSON.

The fuel bills of a railroad constitute ordinarily about 10 per cent. of the total expense of operation, or from 30 to 40 per cent. of the actual cost of running the locomotive. On important systems the gross amount of coal burned assumes a very large figure—running into millions of tons. Each engine will probably consume $5,000 worth of coal in a year on the average, so that for 1,000 locomotives the annual coal bill would approximate $5,000,000. While this is one of the largest items of expense, there is probably less actually known about it than any other account. We may know in a general way that an engine of a certain class, loaded with a definite tonnage, will haul its train in a given direction over a particular divison with a consumption of so many pounds of coal per 100 ton miles, but here our knowledge stops, and if it should be asked how much is used in ascending the maximum grade, how much on the subordinate grades, and what quantity on the level, there is little likelihood of receiving a correct answer.

The reason for this lack of definite information is not hard to find; in fact, it is quite obvious. While it is a comparatively simple matter to determine the quantity of coal used on a trip throughout a run, by means of track scales and measured supplies taken en route, it is very difficult and laborious to subdivide it between terminal points, in the proper proportion to the work done on each of the various grades. An approximation is sometimes obtained by counting the shovelfuls thrown into the firebox between different points, but this, of course, cannot be considered an accurate method. The ordinary exigencies of railroad traffic are so many and varied that it is almost impossible to maintain fixed conditions for a length of time sufficient to determine factors of unquestioned value.

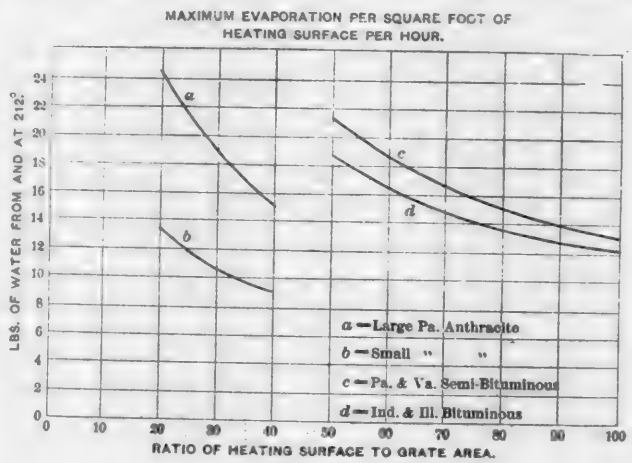


FIG. 1

The same comments apply equally to the consumption of water. Even if meters be placed in the feed pipes, the inconvenient location for observation and the variable methods of working the injector by allowing different heights of water in the boiler, not to speak of leaks and wastes, militate against accurate measurements. Thanks, however, to the "Locomotive Testing Plant," we are now able to work an engine for a long period under constant conditions, and at the same time make accurate measurements of the fuel and water consumed.

Several years ago, when connected with the Chicago and Northwestern Railway, the author was able to make a complete set of tests with the standard heavy freight engine of that road, first upon the testing plant and afterwards in road service with a dynamometer car. Using the results of these tests as a foundation, it has been found possible to elaborate a diagram for practically any particular locomotive whose general dimensions are known, which will give at once the coal consumption per mile or per hour for various grades and speeds or train loads. This diagram is based upon theoretical as well as practical considerations, and will, it is believed, give values agreeing closely with actual conditions.

The construction of the diagram and the method of using it can, perhaps, be made most clear by assuming a locomotive of certain proportions, and developing the study for this engine. We will therefore consider a consolidation locomotive or 2—8—0 type having the following general dimensions:

Diameter of cylinders	21	ins.
Stroke of piston	32	"
Diameter of drivers	56	"
Boiler pressure	200	lbs.
Grate area	40	sq. ft.
Heating surface	3,200	" "
Weight of engine and tender	150	tons.

The theoretical tractive force of such a locomotive will be

$$T.T.F. = \frac{P\,d^2\,s}{D} \qquad 1$$

where P = Boiler pressure in lbs. per sq. in.
d = Diameter of cylinder in ins.
s = Stroke of piston in ins.
D = Diameter of drivers in ins.

When we allow for drop in steam pressure and internal resistance, we find that the available tractive force at circumference of the drivers is only 8-10ths of the theoretical tractive force, or,

$$A.T.F. = \frac{.8\,P\,d^2\,s}{D} \qquad 2$$

for simple engines, when working at slow speeds with the reverse lever in the corner notch.

For the engine under consideration we therefore find as follows:

$$T.T.F. = \frac{200 \times 441 \times 32}{56} = 50{,}000 \text{ lbs. approx.}$$

$$A.T.F. = .8 \times 50.000 = 40{,}000 \text{ lbs. approx.}$$

As the speed of the locomotive increases, however, beyond the point where the boiler can supply the complete volume of the cylinders at each stroke, an earlier cut-off must be used, and it is necessary to determine the effect of such a change. In order that this may occur at the maximum possible speed, the boiler must be worked to its full capcity, which is limited by its ability to burn fuel. From various tests it seems as if this limit might be considered as stated below, the quantities being expressed in pounds of coal per square foot of grate area per hour:

Bituminous coal	200	lbs.
Anthracite, large sizes	100	"
Anthracite, small sizes	60	"

We will assume that our engine is burning Pennsylvania or Virginia semi-bituminous coal, therefore the maximum combustion will be 40 × 200 = 8,000 lbs. coal per hour. We admit that this is a large amount to be handled by one man for any great length of time, but there is no doubt that it could be burnt, if supplied.

In order to determine the quantity of steam generated by this amount of fuel in the boiler which we have assumed, Fig. 1 is introduced. This has been compiled from various sources of information, and, it is thought, fairly represents the average practice in this country. In this figure, the ordinates give the maximum evaporation in pounds of water from and at 212 deg. F. per sq. ft. of heating surface per hour than can be expected under ordinary conditions, as stated above, the abscissae denoting the ratio of heating surface to grate area. For the engine in question this will be

$$\frac{3200}{40} = 80,$$

and for semi-bituminous coal, curve c, we find that with a ratio of 80, 15 lbs. of water, from and at 212 deg. may be evaporated per hour from each square foot of heating surface, or for the boiler as a whole, 3,200×15 = 48,000 lbs. per hour.

*A paper read before the American Society of Mechanical Engineers.

The factor of evaporation from ordinary temperatures of feed water will be about 1.2, so that we shall have at boiler pressure, $\frac{48{,}000}{1.2} = 40{,}000$ lbs. per hour.

The steam will be somewhat reduced in pressure at the cut-off point, however, and the table here given indicates the probable relation of this pressure to the boiler pressure, when the reverse lever is in the corner notch, and the throttle wide open.

RATIOS OF CUT-OFF PRESSURE TO BOILER PRESSURE.

Revolutions per Minute	Starting.	50	100	150	200
Long ports	.98	.94	.88	.83	.78
Short ports	.98	.92	.85	.77	.72
Medium ports	.98	.96	.86	.80	.75

By long ports is meant those in which the length of port in inches divided by the area of the cylinder in square inches is approximately .12, and by short ports, where this ratio is about .05. If we assume .90 for the ratio in the case in hand, we shall have $200 \times .90 = 180$ lbs. at cut-off, which steam will weigh .432 lbs. per cu. ft. The volume of a cylinder 21 ins. diameter and 32 ins. long is 6.4 cu. ft., or for one revolution four times this amount or 25.6 cu. ft. No allowance is made for clearance, as the cut-off with lever in the corner is usually about 90 or 92 per cent. of stroke. For each revolution, then, the steam consumption will be

$$25.6 \times .432 = 11.06 \text{ lbs.}$$

and

$$\frac{40{,}000}{60 \times 11.06} = 60 \text{ r. p. m.}$$

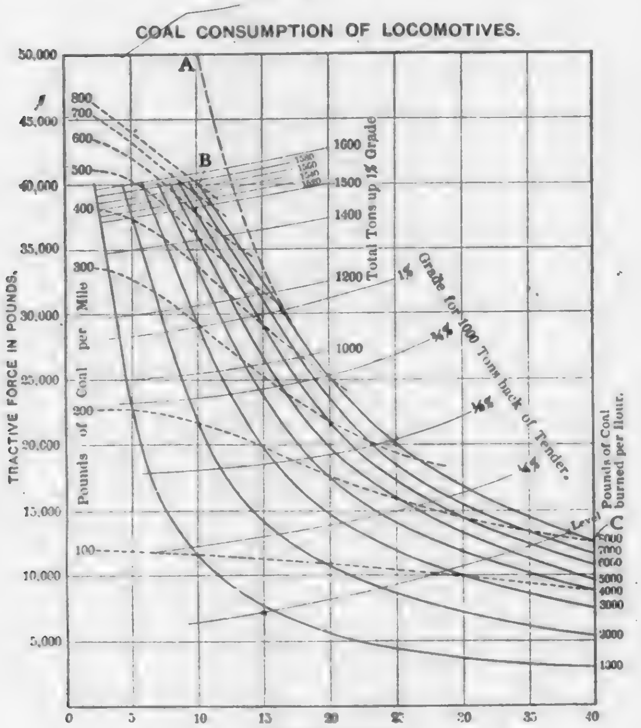


FIG. 2

as the maximum speed at which the boiler will furnish steam at full stroke. The speeds in miles per hour corresponding to the revolutions per minute for a 56-in. wheel are as follows:

5	10	15	20	25	30	35	40	miles per hour.
30	60	90	120	150	180	210	240.	revs. per min.

therefore it is plain at above 10 miles an hour, the cut-off must be reduced, diminishing the available tractive force of the engine.

A study of the variation in tractive force due to speed indicates that the method explained below gives a close approximation to actual results.

In Fig. 2 the ordinates represent the tractive force in lbs., and the abscissae the speed in miles per hour. As the maximum speed at full stroke was found to be 60 r.p.m. or 10 miles an hour, we find the intersection of this speed with the theoretical tractive force at *A*. We therefore construct an equilateral hyperbola through this point, that is a curve the product of whose ordinates will always have the same value, viz., $50{,}000 \times 10 = 500{,}000$. As we have seen, the available tractive force, however, cannot exceed 40,000 lbs. By drawing from the point *B* a tangent to the hyperbola, we then have a locus consisting of a straight line and a curve, and this locus gives us the maximum available tractive force (at circumference of the drivers) for which the boiler will supply the cylinders at any speed. But to do this, we must burn 8,000 lbs. of coal an hour, so that the locus *BC* also gives the combinations of speed and available tractive force which may be obtained by the combustion of 8,000 lbs. of coal an hour.

The rate of combustion per sq. ft. of heating surface per hour is $\frac{8{,}000}{3{,}200} = 2.5$ and from Fig. 3 (curve *c*) we should expect 6 lbs. of water per lb. of coal from and at 212 deg.,

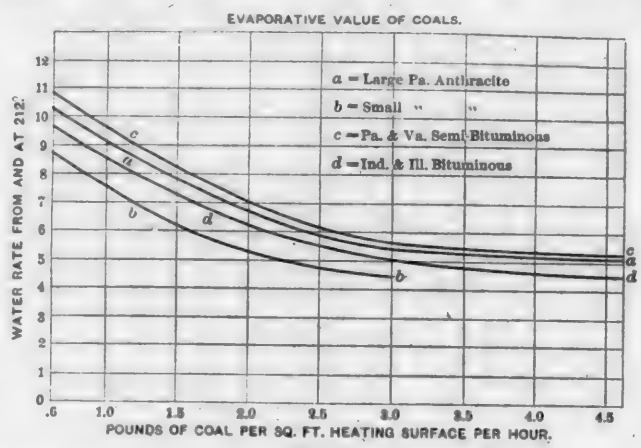


FIG. 3

or a total steam production of $8{,}000 \times 6 = 48{,}000$ lbs., which is the same as our first figure. If the rate of combustion be reduced, however, there will be more steam generated per lb. of coal, as indicated by Fig. 3. For instance, if ¾ the amount be consumed, or 6,000 lbs., the rate of combustion will be $\frac{6{,}000}{3{,}200} = 1.87$ lbs. per sq. ft. of heating surface, and from Fig. 3 the evaporation will be about 7 or $7 \times 1.87 = 13.09$ lbs. of water per sq. ft. of heating surface per hour, instead of 15 lbs. as before. This would supply the cylinders at full stroke for 15 : 13.09 :: 10 : 8.7 miles an hour. From this, as a starting point, we construct a new hyperbola and tangent as before, which locus gives the combinations of speed and tractive force for 6,000 lbs. of coal an hour. In the figure, the loci have been drawn for each 1,000 lbs. per hour from 1,000 to 8,000.

If, now, we divide the quantities per hour by the speed, we obtain the fuel consumption per mile, and this is shown by the dotted lines. Thus, with a tractive force of 20,000 lbs. and a speed of 15 miles an hour, we should expect an hourly consumption of 3,000 lbs. or 200 lbs. per mile.

But as our diagram (Fig. 2) is based on speed and tractive force as co-ordinates, we can construct additional curves, which may represent the force needed to pull various trains at different speeds or up grades. For instance, if we consider a train of 1,000 tons weight back of tender, or 1,150 tons total weight, we can lay down the curves of resistance for a level, ¼, ½, ¾ and 1 per cent. grade, as shown in the diagram. By this means we can determine the quantity of coal that would be used on different portions of a division.

If there were 40 miles each of level, ½ and 1 per cent. grade, the fuel consumption would run as follows:

40 miles @ 38 miles an hour, 210 lbs. per mile = 8,400 lbs.
40 miles @ 24 miles an hour, 330 lbs. per mile = 13,200 lbs.
40 miles @ 17 miles an hour, 490 lbs. per mile = 19,600 lbs.

Total .... 41,200 lbs.

It will be noticed that this considers the train to be run at

the maximum speed which the engine can make on each grade or portion of track. If the speed be limited to 15 miles an hour uniformly, we should expect consumption as follows:

40 miles on level @ 50 lbs. per mile	=	2,000 lbs.
40 miles on ½% grade @ 190 lbs. per mile	=	7,600 lbs.
40 miles on 1% grade @ 430 lbs. per mile	=	17,000 lbs.
Total		26,800 lbs.

This trip of 120 miles will, however, require 8 hours for its completion, whereas the first schedule is a trifle over 5 hours. The coal consumption in the first case is over 50 per cent. greater than in the second case. The effect of speed upon the coal pile is clearly shown by following any of the grade lines in the diagram. The rate per mile on a ½ per cent. grade will be about as given below:

Miles per hour	5	10	15	20
Coal per mile, lbs.	150	160	185	250

The influence of loading is shown by the curves marked "Total tons up 1 per cent. grade."

At 10 miles an hour, 250 lbs. per mile for 1,000 tons.
At 10 miles an hour, 325 lbs. per mile for 1,200 tons.
At 10 miles an hour, 500 lbs. per mile for 1,400 tons.

When we near the limit of capacity of the engine, the difference is still more marked.

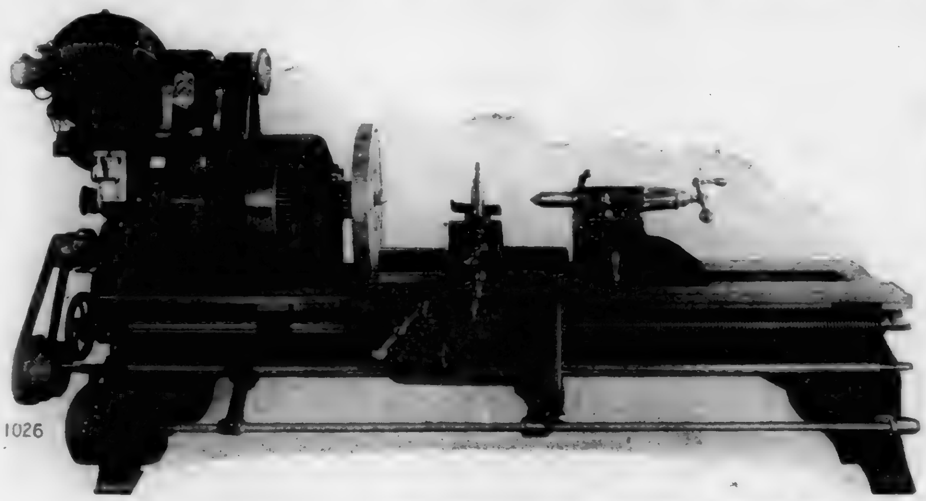
At 10 miles an hour, 630 lbs. per mile for 1,500 tons.
At 10 miles an hour, 680 lbs. per mile for 1,520 tons
At 10 miles an hour, 720 lbs. per mile for 1,540 tons
At 10 miles an hour, 780 lbs. per mile for 1,560 tons.

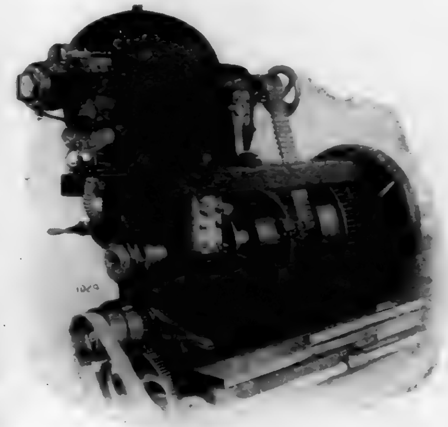
Again, 1,600 tons can be hauled at 5 miles an hour with a consumption of 500 lbs. per mile, whereas 1,570 tons at 10 miles an hour will require 800 lbs. per mile, both cases being the maximum that the engine can do.

These examples give an idea of the variety of problems in fuel consumption which can be quickly solved by the aid of this diagram. It is true that a different diagram must be made for each class of engine, but this is a comparatively small matter. With the increase in speed and loads of the present day, the coal consumption becomes a topic of great interest, and when comparisons are made with previous schedules, there is an apparent decrease in the economy of fuel, unless the various points are duly considered, and as explained by the chart.

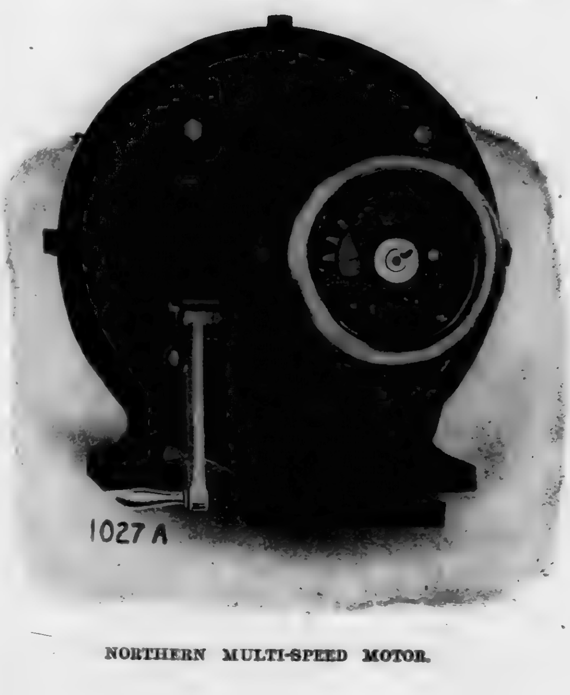
MUTI-SPEED MOTOR.

The problem of equipping old machine tools with variable speed motors, and furnishing such machines as lathes with a sufficiently wide range of speed, has been complicated because of the additional mechanical speed changes required to supplement the electrical speed variations. The expense and the amount of work required to do this properly are such that many are discouraged from applying motors to belt-driven tools, much as they might wish to avail themselves of the benefits to be derived from such a change. A multi-speed motor has just been placed on the market by the Northern Electrical Manufacturing Company, which consists of a variable speed field control motor with a mechanical change gear device attached to and forming part of it, as shown in the illustrations. By this means a speed variation of 4½ to 1 can





NORTHERN MULTI-SPEED MOTOR APPLIED TO BLAISDELL LATHE.



NORTHERN MULTI-SPEED MOTOR.

be obtained by the use of a 2 to 1 motor, or with a 3 to 1 motor a total speed range of 9 to 1 can be obtained. The change gears are run in oil and are noiseless.

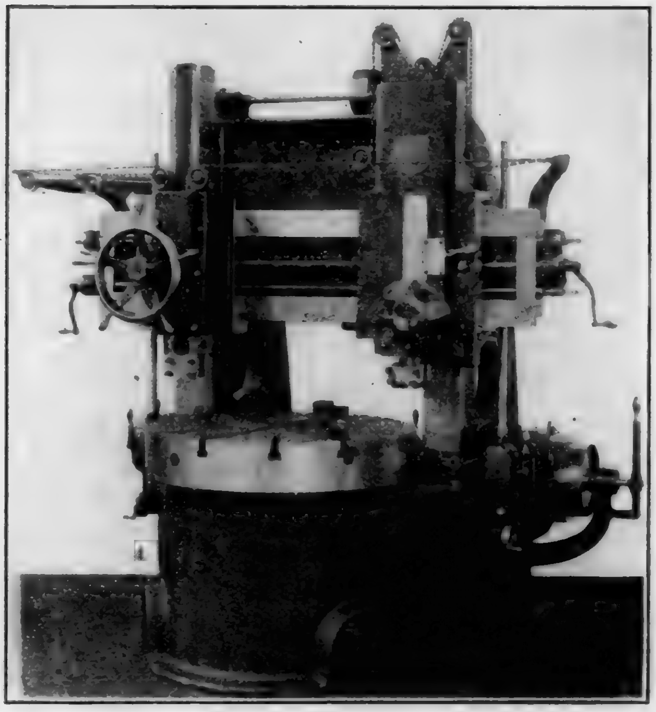
Probably no class of machine tools is more difficult to change from the belt to a motor drive than the ordinary engine lathe. As the speed range of a variable speed motor is considerably less than the back gear ratio of a belt-driven lathe, it becomes necessary, in order to avoid a large gap between the two runs of gearing, to change the back gear ratio, and this introduces a number of complications. These difficulties disappear with the introduction of the multi-speed motor, as will be noted by a study of the application of one of these motors to a 24-in. Blaisdell lathe shown in the accompanying illustrations. The spindle bearing caps were simply removed and a cast iron bracket which supports the motor was substituted in their place. The motor in connection with the change gears had a sufficient speed variation so that it was not necessary to change the back gear ratio. The motor was connected by a silent chain to the split sprocket clamped on one of the steps of the cone pulley. The motor controller was bolted to the lathe bed and is operated through the spline shaft and the lever on the carriage.

The controller furnishes 20 speeds, and thus by means of the controller handle and the change gear lever 40 speeds may

readily be obtained without stopping the machine. The use of the back gear on the lathe doubles this number and gives the lathe a very wide range of speed. The machine can be stopped for examination or measurement of work without stopping the motor and quickly started again by the clutch lever on the change gear device. With a 5 to 1 motor a speed variation of 15 to 1 can be obtained.

42-IN. BORING MILL.

A powerful and conveniently operated boring mill is shown in the engraving. By means of the turret head with five sides, at the right, the output of the machine can be materially increased on certain classes of work. The 3-jaw universal chuck is built into the table, which is 40 ins. in diameter. Power is transmitted from a cone pulley to the table through two frictions and a back gear, giving four changes of table speed for each step of the cone. These mechanical changes can be made instantly, while the machine is in motion.



42-IN. BORING MILL.—KING MACHINE TOOL COMPANY.

A motor may be readily applied by gearing direct to the driving mechanism, and without the use of brackets. With a constant speed motor 12 table speeds may be obtained. The table is driven by accurately planed bevel gears.

Eight positive horizontal and vertical feeds, varying from 1-40 to ½ in., are provided. The heads are independent in their movements, both as to direction and amount of feed By means of friction clutches the rail may be quickly and noislessly raised or lowered by power. This machine is made by the King Machine Tool Company of Cincinnati, Ohio, and weighs about 12,000 lbs.

Gas Turbines.—From an elaborate paper read by Mr. R. M. Neilson before the Institution of Mechanical Engineers in London, October 21, the following impressions are received. First—The gas turbine seems at present a mechanical impossibility although the difficulties may perhaps be overcome. Second—The temperatures necessary to be used are sufficiently high to heat the blades of the turbine to a bright red heat, which would soon burn them up. Third—Compressors need to be greatly improved in efficiency for this work or the power required for compression will be practically equal to that delivered from the turbine. This is a discouraging outlook, but many minds are at work, at home and abroad, upon the problem.

TWIST DRILL TESTS.

The following results of tests made with twist drills are taken from a paper on "A Twist Drill Dynamometer," presented before the December meeting of the American Society of Mechanical Engineers by Messrs. W. W. Bird and H. P. Fairchild. The tests were conducted at the Washburn shops of the Worcester Polytechnic Institute, on a machine which measured and registered both the twisting moment and the thrust of the drill.

Blocks of soft gray iron were obtained and tested in the machine itself, so as to get a number for each set of experiments as near the same degree of hardness as possible. A ⅝-in. Novo steel drill was used. The first experiments were on the effect of speed or number of revolutions per minute,

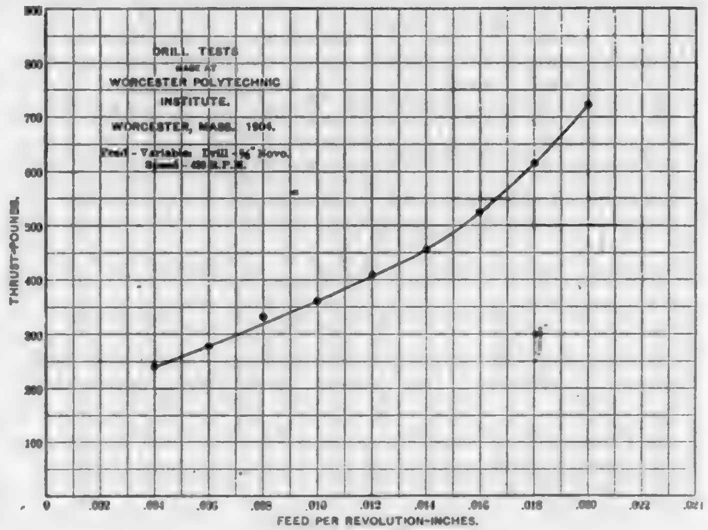


FIG. 1.

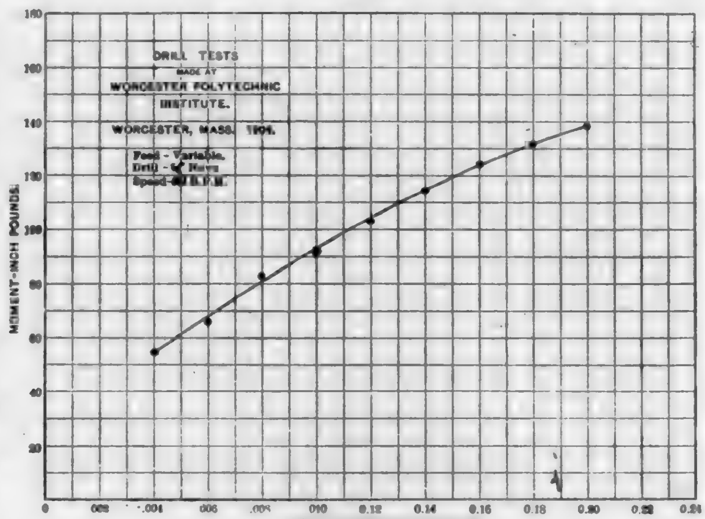


FIG. 2.

all other conditions remaining the same. The revolutions were varied from 140 to 600, but no material difference was shown by the cards in either thrust or twist. In other words, the power required to turn the drill varies directly with the number of revolutions, while the thrust does not increase with the speed, but depends upon the feed or the advance per revolution.

The next set of experiments was made to determine the relation between thrust and feed, the revolutions per minute remaining constant. From the first set of experiments it was shown that the limit of speed would depend upon the endurance of the drill, and with heavy feeds 420 revolutions was not far from this limit. Accordingly, the second set was run at this speed, which for a ⅝-in. drill is about 70 ft. per minute for the cutting rate for the outer edges, and for .020-in. feed a rate of drilling of about 8 ins. per minute. The range of feed was taken from .004 to .020 ins. per revolution, the

drill at the coarsest feed being somewhere near its limit. These feeds were all positive, a train of gears being substituted for the regular belt drive. The results are plotted in Fig. 1, and show that the thrust increases very rapidly with the coarser feeds.

Fig. 2 is a curve, giving the relation between moment and feed, and shows that the moment does not increase at the same rate as the thrust. This would seem to indicate that less power is required to drill a given hole in a given time by increasing the feed per revolution rather than by increasing the revolutions. For example, to drill a hole in a 1-in. plate in 10 seconds could be done by running the drill 600 r.p.m., and feeding .010 ins. per revolution, but would require more power than by running at 300 revolutions with a feed of .020 ins.

The question of the proper angle of the drill was next considered, and a set of experiments made with a constant speed and feed, the half-angle varying from 37 deg. to 70 deg., 22 deg. less and 11 deg. more than the standard, 59 deg.

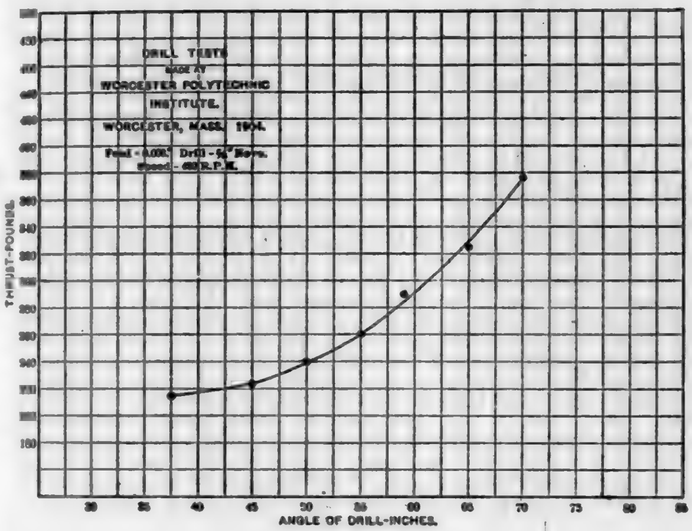


FIG. 3.

The results are plotted in Fig. 3, and show that the thrust would be decreased by having more of a point on the drill. With an angle of 37 deg., however, the drill would not stand up on repeated work. At 45 deg. it seems to do the work as well as at 59 deg., and with much less thrust. This would suggest a change in the standard angle for the new steels. The moment for the various angles remained practically constant, so that the driving power does not change with the angles of the drill. Another interesting point in drilling, which can be shown with this machine, is the effect of first removing the center of the hole by the use of a small drill. Ten holes were drilled in a bar of cast iron with small drills, ranging from No. 53 to ½ in. in diameter, and then each one counterbored with a ⅝-in. drill at 420 r.p.m. and a feed of .008 in. per revolution. The following table gives the thrust in each case, and shows that a hole 1-10 in. in diameter takes off about one-half the thrust for a ⅝-in. drill.

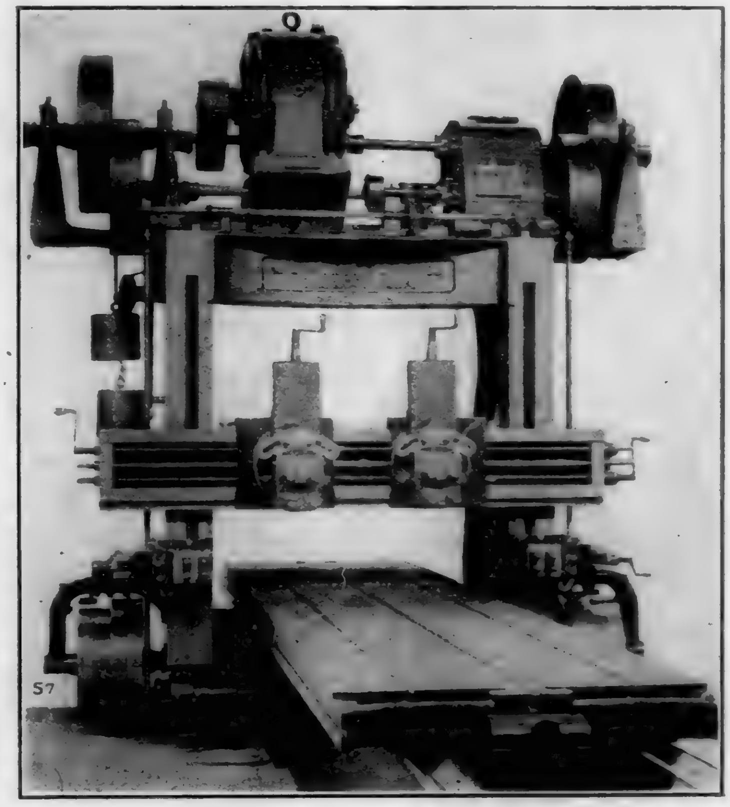
Size of first hole—										
.000	.0595	.0760	.0935	.120	.157	.189	.221	.250	.375	.50
Thrust for counterbore—										
340	190	180	170	155	145	130	120	90	70	30

ECONOMY OF ELECTRIC TRACTION.—The saving in coal with a central station electric power plant over steam locomotives is greater than is often assumed. The plant of the Manhattan Elevated delivers power to the switchboard at the rate of 2.6 lbs. of coal per k.w.-hour under conditions of full load, and the power is delivered to the motors through the third rail with about 60 per cent. efficiency, giving a consumption of 4.3 lbs. per k.w. or 3 lbs. per h.p. at the drawbar. A road with heavy traffic and a large and efficient central power station should use only about half as much coal as when using steam locomotives, and this may even be reduced under favorable conditions to one-third.—*L. B. Stillwell, before International Engineering Congress.*

NEW PLANER DRIVE.

The photograph illustrates a planer arranged for 6 different cutting speeds with a constant return speed and driven by a constant high speed motor. This has two advantages over the variable speed motor drive; the power is not reduced at slow speeds, and the return speed is constant and does not vary with the cutting speed. Power is transmitted from the motor to the shaft which carries the pulleys for the return stroke by a Morse silent chain. Motion is in turn transmitted through a speed box to a shaft which carries the pulleys which drive the platen on the cutting stroke. The speed box contains 2 trains of gearing, each of which will give three different speeds to the platen. The speeds are changed by means of levers at the side of the planer which can be operated either while the machine is in motion or standing idle. The gears in the speed box are steel and run in oil, thus reducing wear and noise to a minimum. The entire box is inclosed and holds about 5 gallons of oil.

Owing to the high cutting speed at which the planer operates, a double driving mechanism is used. A complete set of



CINCINNATI PLANER WITH IMPROVED DRIVE.

driving pulleys for both the forward and return motion of the platen are attached on each side of the machine, thus doubling the belt capacity and still retaining the ease of shifting, which would be impossible if 1 belt 7 ins. wide was used in place of 2 belts 3½ ins. wide. All the pulleys on the top shafts are made with a heavy rim, thus acting as flywheels and relieving the motor when the platen is reversing in either direction.

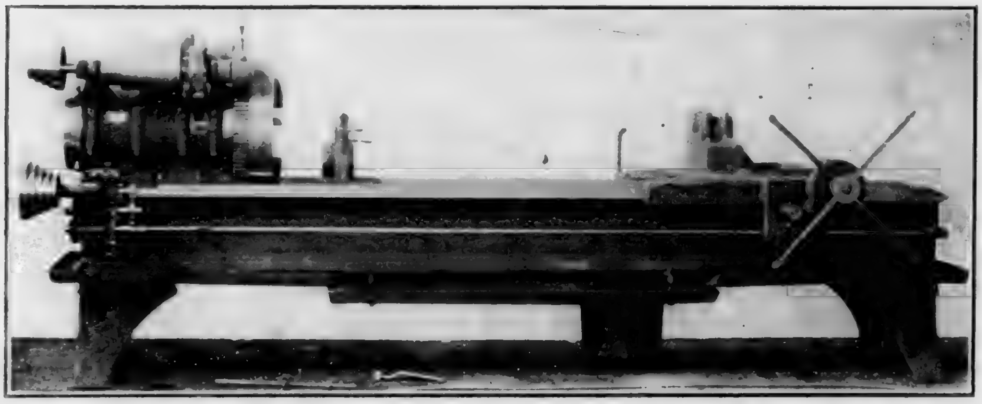
The cutting speeds furnished are 22, 27, 32, 40, 50 and 60 ft. per minute, with a constant return of 75 ft. per minute. An index plate placed on the side of the housing indicates the cutting speed in use. The planer is driven by a 30-h.p. Westinghouse alternating 3-phase motor. The machine will plane work 66 ins. wide, 60 ins. high and up to 21 ft. in length. It is fitted throughout with steel gearing and was built by the Cincinnati Planer Company, Cincinnati, who are in position to put a similar speed variator on all sizes of their machines.

It does not matter what the cost of your repairs is, but it does matter whether the cost is going up or down.

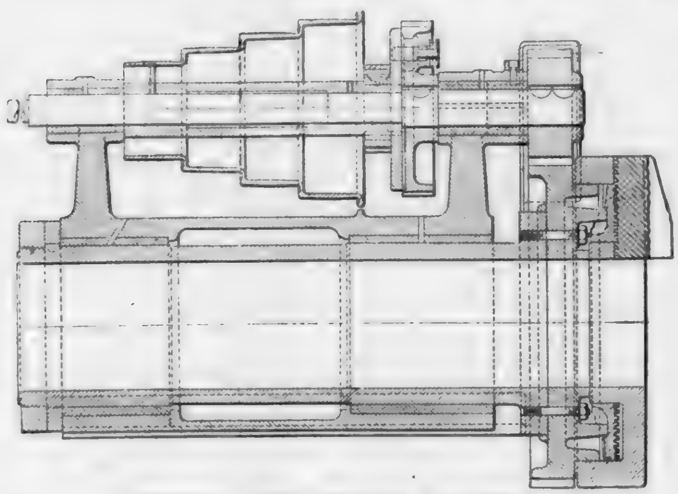
AXLE BORING MACHINE.

The Pennsylvania Railroad makes a practice of boring a 2-in. hole longitudinally through all driving axles above a certain size, to guard against defective material and defects in forging not found in smaller axles, where the material can be more thoroughly worked. This is done at a relatively small cost by the Springfield axle boring machine, shown in the photograph, and specially designed for this purpose.

This machine will bore holes from ¾ in. to 6 ins. in diameter through stock up to 11 ins. in diameter and 84 ins. in length. The bar to be bored is held by a three-jaw universal scroll chuck, secured to a flange cast on the front of the spindle, and is supported and held central at the other end of the spindle by adjustable screws. The spindle consists of a cast iron shell, as shown in the sectional view, and has long bearings in the headstock. A large gear cut into the rear of the chuck on the spindle engages with a pinion on the auxiliary shaft, upon which the four-step driving cone is mounted. By means of the back gears and a two-speed countershaft 16 spindle speeds are furnished in geometrical progression.



SPRINGFIELD SPINDLE AND AXLE BORING MACHINE.



SECTIONAL VIEW THROUGH HEADSTOCK.

The center of the headstock is placed as low as possible, and the long carriage which carries the boring tool is moved by pinions, which mesh into two racks, one on each side of the top of the bed. This makes a very powerful arrangement, and reduces the stresses on these parts to a minimum. The carriage slides on two large V's, and is gibbed its full length to the outside of the bed. Ten feeds are provided from .0005 in. to .01 in. per revolution. The power feed is engaged by a powerful friction clutch.

By means of the large pilot wheel, the carriage can rapidly be moved to any position. The guide for centering the boring tool is used only for starting the tool, after which it may be swung out of the way. The cutting edges of the tool are lubricated, and the chips are washed out, by oil supplied by a force pump. The pan which surrounds the machine has a large capacity, and the lubricant has sufficient time to cool before being used again. This machine weighs 7,000 pounds, and is the larger of two sizes made by the Springfield Machine Tool Company, of Springfield, Ohio.

HIGH SPEED TOOL STEEL.

(Concluded from Vol. 78, Page 48.)

For hardening and tempering specially formed tools of high speed steel, such as milling and gear cutters, twist drills, taps, screwing dies, reamers, and other tools that do not permit of being ground to shape after hardening, and where any melting or fusing of the cutting edges must be prevented, another method of hardening is used. A specially arranged muffle furnace heated either by gas or oil is employed, and consists of two chambers lined with fire clay, the gas and air entering through a series of burners at the back of the furnace, under control so that a temperature up to 2,200 deg. Fahr. may be steadily maintained in the lower chamber, while the upper chamber is kept at a much lower temperature. Before placing the cutters in the furnace it is advisable to fill up the hole and keyways with common fire clay to protect them. The cutters are first placed upon the top of the furnace until they are warmed through, after which they are placed in the upper chamber and thoroughly and uniformly heated to a temperature of about 1,500 deg. Fahr., or, say, a medium red heat, when they are transferred into the lower chamber and allowed to remain therein until the cutter attains the same heat as the furnace itself, about 2,200 deg. Fahr., and the cutting edges become a bright yellow heat, having an appearance of a glazed or greasy surface. The cutter should then be withdrawn while the edges are sharp and uninjured, and revolved before an air blast until the red heat has passed away, and then while the cutter is still warm—that is, just permitting of its being handled—it should be plunged into a bath of tallow at about 200 deg. Fahr., and the temperature of the tallow bath then raised to about 520 deg. Fahr., on the attainment of which the cutter should be immediately withdrawn and plunged in cold oil. There are various other ways of tempering, a good method being by means of a specially arranged gas and air stove into which the articles to be tempered are placed, and the stove then heated up to a temperature of from 500 to 600 deg. Fahr., when the gas is shut off and the furnace with its contents allowed to slowly cool down. Another method of heating tools is by electrical means, by which very regular and rapid heating is obtained, and where electric current is available, the system of electric heating is quick, reliable and economical.

Electricity also furnishes a very efficient and accurate means of tempering such forms of tools as milling, gear, hobbing and other similar cutters, also large hollow taps, hollow reamers, and all other hollow tools made of high speed steel, where it is required to have the outside or cutting portion hard, and the interior soft and tenacious, so as to be in the best condition to resist the great stresses put upon the tool by the resistance of the metal being cut, and which stresses tend to cause disruption of the cutter if the hardening extends too deep.

Tempering of hollow cutters, etc., is sometimes carried out by the insertion of a heated rod within the cutter and so drawing the temper, but this is not entirely satisfactory, or scientific, and is liable to induce cracking by too sudden heat application, and further because of the difficulty of maintaining the necessary heat and temperature required, and afterward gradually lowering the heat until the proper degree of temper

has been obtained. In electrical tempering these difficulties are overcome, as the rod is placed inside the cutter quite cold, and the electric current gradually and steadily heats up the rod until the correct temperature is reached, when it can be held at such temperature as long as is necessary, and the current can be gradually reduced until the articles operated on are cold again, and consequently the risk of cracking by too sudden expansion and contraction is reduced very greatly.

That great economy is effected from using high speed steel is beyond all doubt, for rapidity of cutting is increased, and the output of machines correspondingly, so that a greater production is obtained from a given installation than was possible when cutting at low speeds with the old tool steel, and the work is naturally produced at a correspondingly lower cost. It follows from this that in laying down new plant and machines the introduction and use of high speed steel would have considerable influence in reducing expenditure on capital account. It has also been proved that high speed cutting is economical from a mechanical standpoint, and that a given horse-power will remove a greater quantity of metal at a high speed than at a low speed, for although more power is naturally required to take off metal at a high than at a low speed, the increase of that power is by no means in proportion to the large extra amount of work done by the high speed cutting, for the frictional and other losses do not increase in the same ratio that a high cutting speed bears to a low cutting speed. A brief example of this may be given in which the power absorbed in the lathe was accurately measured electrically. Cutting on hard steel, with 3-16 in. depth of cut, 1-16 in. feed and speed of cutting 17 ft. per minute, a power of 5-16 h.p. was absorbed, and increasing the cutting speed to 42 ft. per minute, the depth of cut and feed being the same, there was a saving in power of 19 per cent. for the work being done. Another experiment with depth of cut ⅜ in. and traverse 1-16 in. compared with 1-16 in. traverse and 3-16 in. depth of cut, showed a saving in power of as much as 28 per cent., and still proceeding with a view of increasing the weight of metal removed in a given time the feed was doubled (other conditions being the same) and a still further saving of power resulted. In a word, as in the majority of things, so it is with rapid cutting, the more quickly work can be produced the cheaper the cost of production will be.

Again as regards economy there is not only a saving effected on the actual machine work, but since the advent of high speed cutting it is now possible, in many instances, to produce finished articles from plain rolled bars, instead of following the old practice of first making expensive forgings and afterward finishing them on the machine. By this practice not only is the entire cost of forging abolished, but the machining on the rolled bar can be carried out much quicker and cheaper in suitably arranged machines, quicker even than the machining of a forging can be done. Remarkable results are also obtained by operating on stock bars with high speed milling cutters.

Rapid cutting with planing tools has also developed extensively, the old cutting speeds of 15 to 25 ft. per minute being now replaced by those of 50 to 60 ft. per minute, and in some cases even as high as 80 ft. per minute, and for the same reasons, as already described in lathe turning, the power absorbed does not increase in anything like the same proportion as the extra amount of work done, so that the wear and tear on the machine is not materially increased.

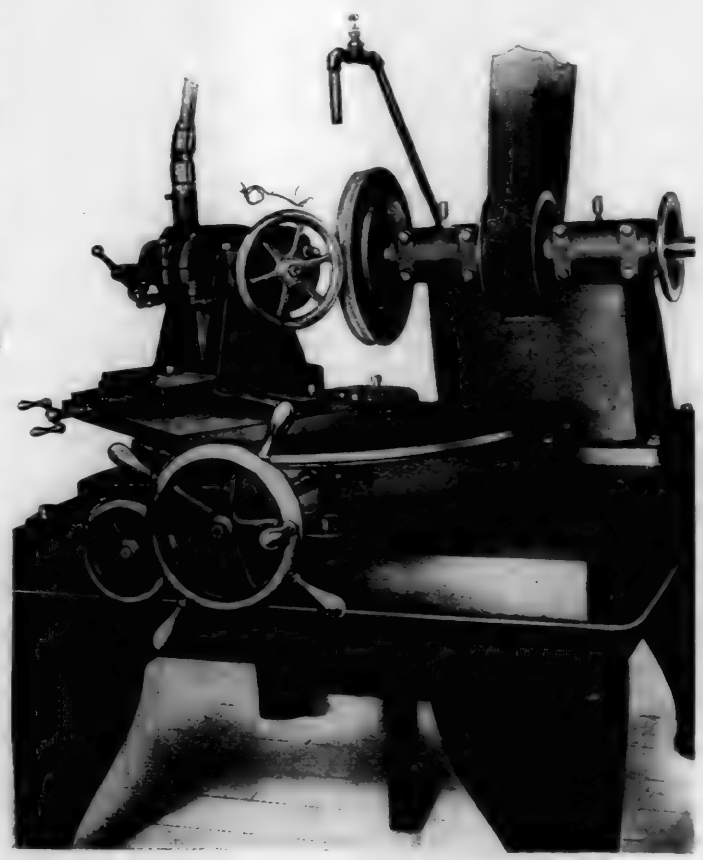
Perhaps one of the most unlooked-for developments in the use of high speed steel has been the manufacture from it of twist drills, and it would be safe to say that in no other sphere has the new steel justified itself to a greater extent than in the operations of drilling and boring, as its powers in that respect have revolutionized completely modern workshop practice. It is now possible in many cases to drill holes through stacks of thin steel plates as quickly and economically as by punching them, thus avoiding the consequent liability to distress the material due to punching action.

As a comparison of the superiority of high speed over ordinary drills, an instructive result was obtained when drilling forged steel gun cradles of 5 ins. thickness, and which steel is of a very tough nature. An ordinary twist drill was first tried and failed after drilling 8 holes, the end being completely fused, but a high speed drill afterward drilled 124 holes without suffering any injury whatever. The drills were 2 ins. diameter, running at 80 revolutions per minute, and each hole was drilled in 6 minutes, this being the full power of the machine. In several instances the author's firm reduced the cost of drilling per 100 holes by over 60 per cent. without even altering the machines in any way, except by speeding them up.

HAND WHEEL GRINDING MACHINE.

The hand wheel grinding machine shown in the accompanying illustration finishes the outer rim of a hand wheel from the rough, ready for the buffer at one operation, without machining it with a tool. A certain hand wheel which required 1 hour to finish by the machining process was finished in 9 minutes on this grinding machine.

The bed, a planed casting 43 by 41 ins. is mounted on a cast iron pan on legs. The grinder head is bolted on the back of the bed. At the front is a dove-tailed slide having 17½ ins. of bearing for the swivel slide. The swivel slide has a cross-feed of 13 ins. to and from the grinder, and upon it is mounted



HAND WHEEL GRINDING MACHINE—LODGE & SHIPLEY MACHINE TOOL COMPANY.

a second slide with its center fixed upon the swivel slide in line with the grinding wheel, so as to center all diameters. The pilot wheel at the front provides a rotary movement about the grinder. A cross adjustment is provided for the head-block carrying the hand wheel to be ground, and the spindle holding the hand wheel is also adjustable, so as to bring different diameters of hand wheels directly over the swivel center. The speed of the hand wheel to be ground is controlled through a universal joint driven from a variable speed countershaft. The Lodge & Shipley Machine Tool Company of Cincinnati are the manufacturers of this machine.

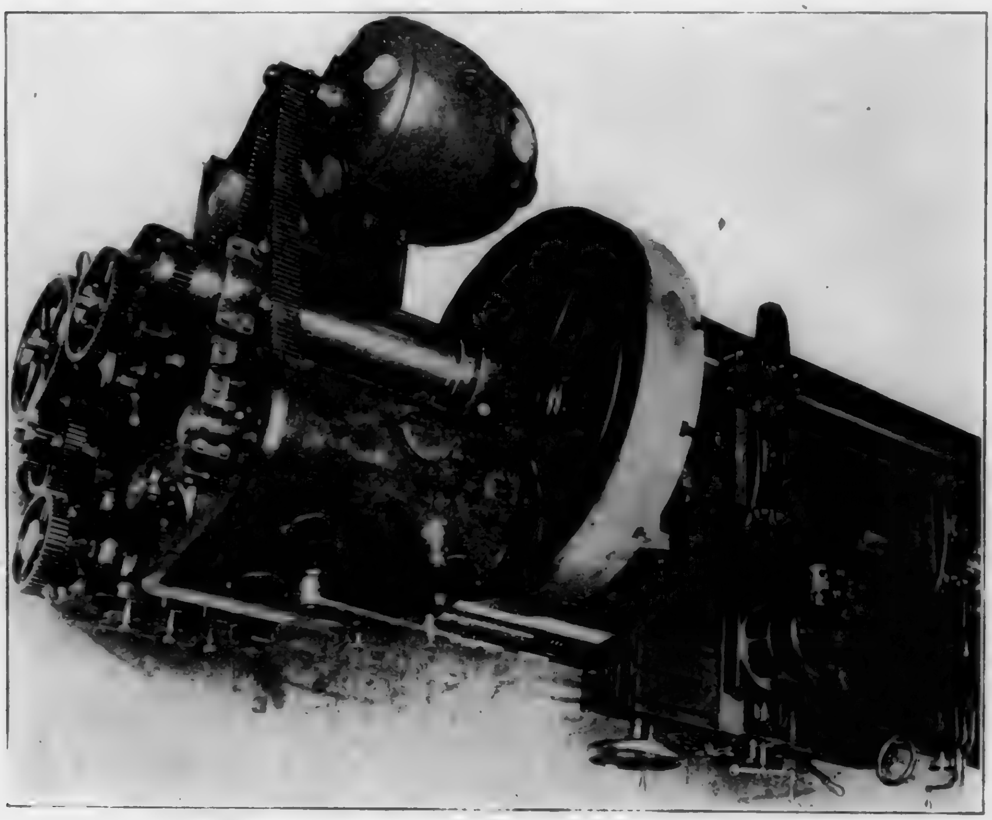
60-INCH MOTOR-DRIVEN ROLL-TURNING LATHE.

This lathe was designed for turning heavy pipe rolls, etc., and is made very substantial throughout to withstand the severe strains which come upon it in connection with this class of work. A Crocker-Wheeler Co. 25 h.p. variable speed motor is mounted on a cast iron stand attached to the bed at the rear of the headstock and is connected to the driving shaft by silent chain, as shown. Releasing the small knobs in either of the handles on the front of the headstock hood allows them to be thrown to the right or left, thus operating the clutches which control the different runs of gearing in the headstock. These speed changes, in addition to those furnished by the motor, afford a wide range of speed with a large number of steps. An index plate, prominently placed, indicates the proper combination to be used for any desired spindle speed. The motor controller is place alongside the motor stand and is operated by the hand wheel at the right hand end of the carriage.

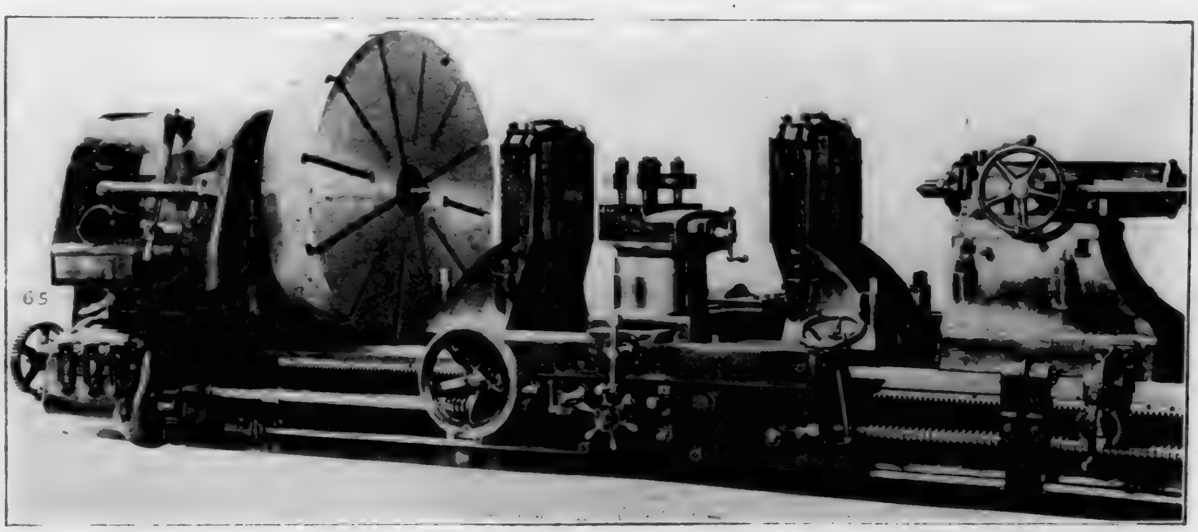
Near the end of the bed, below the headstock, is the feed changing device, and by means of the three levers, which are shown, seven distinct and positive feeds can be obtained without removing a single gear. The feed gears are neatly housed in, and an index plate indicates the combination to be used for any pitch, thread or feed.

What appears to be a taper attachment will be noted in the view looking down on the lathe. It is used to impart curved surfaces to long pipe-straightening rolls and is operated by a shoe provided with anti-friction rollers which slide in a slot. Straight work can be turned by disengaging the nut which holds the shoe and by tightening the cross feed nut. The concaving rest shown in the same view is interchangeable with the compound rest, and is used for grooving out pipe welding rolls. It operates with rotary motion through worm and worm wheel, with either hand or power feed.

The heavy housings shown are for holding heavy pipe roll castings. This lathe is built by the American Tool Works Co., of Cincinnati.



VIEW LOOKING DOWN ON 60-INCH ROLL-TURNING LATHE.



60-INCH ROLL-TURNING LATHE—AMERICAN TOOL WORKS COMPANY.

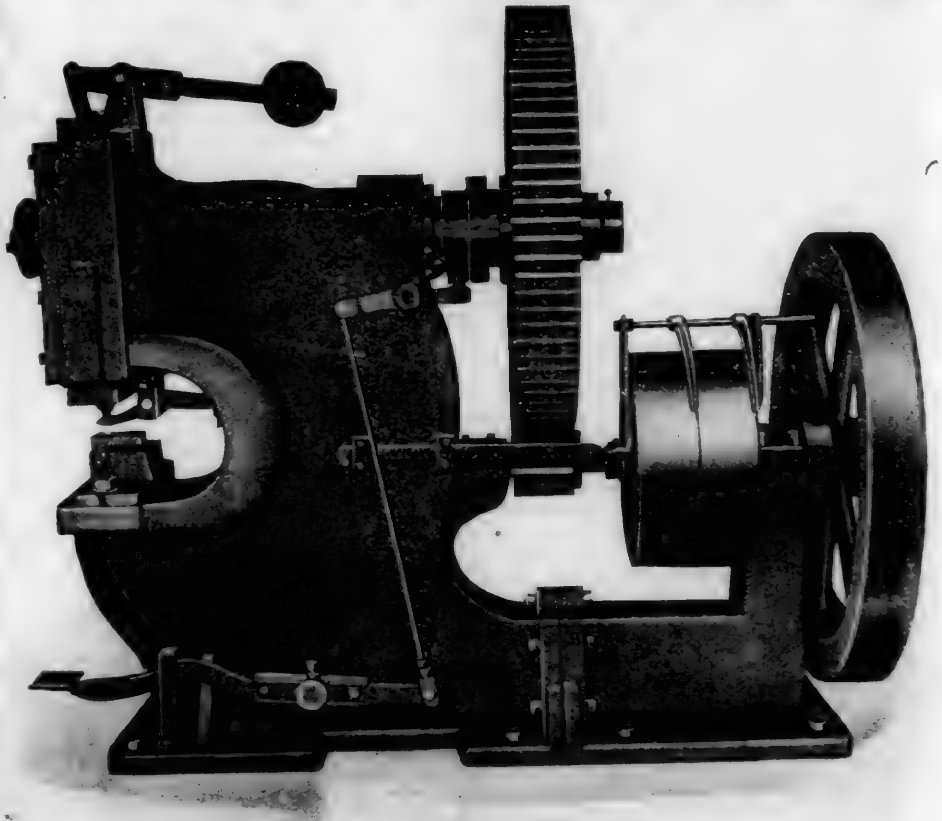
Speed of Steam Turbines.—High speed of rotation has been a rather serious drawback to the steam turbine as applied to marine practice. This has been overcome in designing the machinery for the new Cunarders, the turbines of which are expected to run at about 140 r.p.m. This appears to be an important feature of present development of the turbine for marine service.

Contributions to the Purdue Museum.—The New York, New Haven & Hartford Railway, through the courtesy of Mr. Samuel Higgins, general manager, has arranged to place in the care of Purdue University the historic locomotive, "Daniel Nason." This locomotive was built about 1858, and is one of the 8-wheel type, with cylinders inside the frames and cranked axles, which were common throughout New England 30 years ago. They are also placing in their keeping a stage coach passenger car which was put in service about 1835, and consists of the body of a stage coach suspended over a simple railway truck by means of braces.

IMPROVED FUNCHING MACHINE.

The photograph and drawing illustrate a new positive adjustable stop as used in connection with an improved sliding clutch on a Cincinnati punch. By means of the adjustable stop the machine can be made to stop at either the top or bottom of the stroke or at any intermediate point. This is of special advantage for such work as exact center punching, as considerable time can be saved by having the punching tool automatically stop close to the work.

The mechanism which controls this is simple and consists of a brass cam fastened in the groove of the clutch and held in place by a bolt whose head fits in the deep slot to the left of the groove in which the clutch lever lug works. By loosening the nut on the bolt the cam can be set at any desired point on the circumference. As the cam comes in contact with the lug on the clutch lever, the clutch is thrown out and the machine is stopped. This makes a very simple and positive device.



CINCINNATI PUNCH, WITH POSITIVE ADJUSTABLE STOP AND IMPROVED SLIDING CLUTCH.

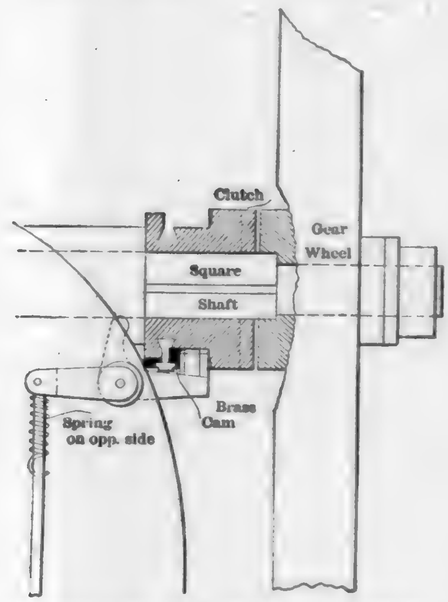
The section of the driving shaft upon which the clutch slides is square, with the distance across the flats equal to the diameter of the round portion of the shaft. This obviates the use of keys or feathers which, because of the heavy intermittent stresses to which the shaft is subjected, are a source of annoyance, and it also greatly increases the strength of the shaft at what is ordinarily its weakest point. These devices are used on the punches and shears made by the Cincinnati Punch & Shear Company.

English Railway Equipment.—The railways of the United Kingdom at the close of last year owned 22,276 locomotives and 801,926 passenger carriages, wagons and other vehicles. In the total for England are included the following stock for lines worked by electricity, viz., 96 locomotives, 642 carriages and 19 other vehicles; and for Ireland the following stock for light railways, viz., 47 locomotives, 134 carriages and other vehicles attached to passenger trains, 497 wagons and 20 other vehicles.

A NEW FRANKLIN AIR COMPRESSOR.

The accompanying illustration shows one of the air compressors recently furnished the Pennsylvania Railroad at Altoona, Pa. They were designed and built by the Chicago Pneumatic Tool Company at Franklin, Pa., and belong to what they designate as their "C. S. C." class of machines, having compound steam cylinders and compound air cylinders. They are designed to run non-condensing with a boiler pressure of 100 lbs. The high and low pressure steam cylinders are 11 and 20 ins. in diameter respectively, and air cylinders 11 and 18 ins., with a stroke of 24 ins. The capacity of each compressor is 700 cu. ft. of free air at a speed of 100 r.p.m.

While graceful in outline, the machine is at the same time massive and compact. All bearings are of unusually generous proportions, the pressure per sq. in. being so reduced as to avoid any tendency to heating, a feature which will be appreciated by those who have had much experience with air compressors. The bearings throughout are provided with removable shells or bronze bushings, with simple but effective provision for taking up wear. The steam cylinders are provided with Meyer adjustable cut-off valves. The main steam



ADJUSTABLE STOP AND SLIDING CLUTCH ON CINCINNATI PUNCH.

valves are double ported, admitting of short ports and consequent reduction of clearance. The high and low pressure main steam valves are efficiently balanced, reducing friction and wear to a minimum. Both air cylinders are provided with mechanically operated inlet valves of the Corliss type, which are placed in the cylinder heads, admitting of close clearance and large port area, with consequent free admission of air. These valves are actuated by the steam cut-off eccentrics, so that four eccentrics drive both steam and air valves, the valve gear being very simple for the work performed. The discharge valves are of the poppet type, being of cup shape, pressed out of sheet steel. The valve seats and guides are removable, and readily accessible for inspection or renewal.

An intercooler, not shown, is provided between high and low pressure air cylinders, which cools air after compression in the low pressure cylinder down to the temperature of the atmosphere. This intercooler, being self-contained, may be placed in any location desired. Owing to small bore of the cylinders and proportionately long stroke, the percentage of clearance in the air and steam cylinders is very small, resulting in high efficiency and economizing of steam. The water jacketing also is much more effective than in the compressors

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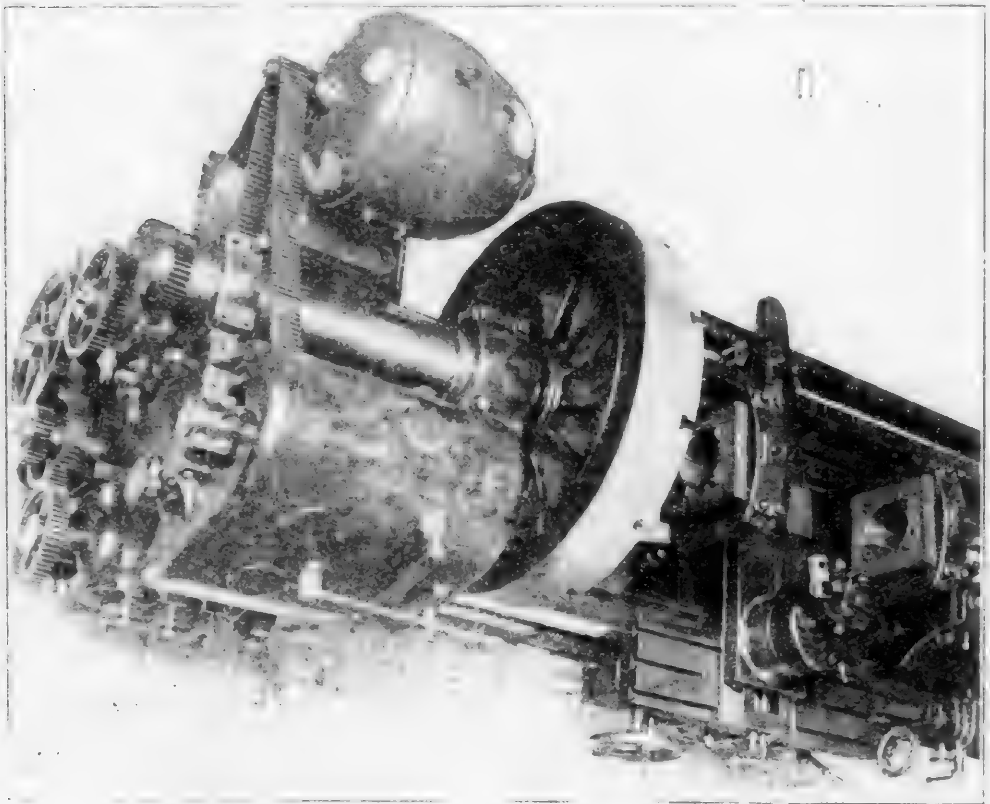

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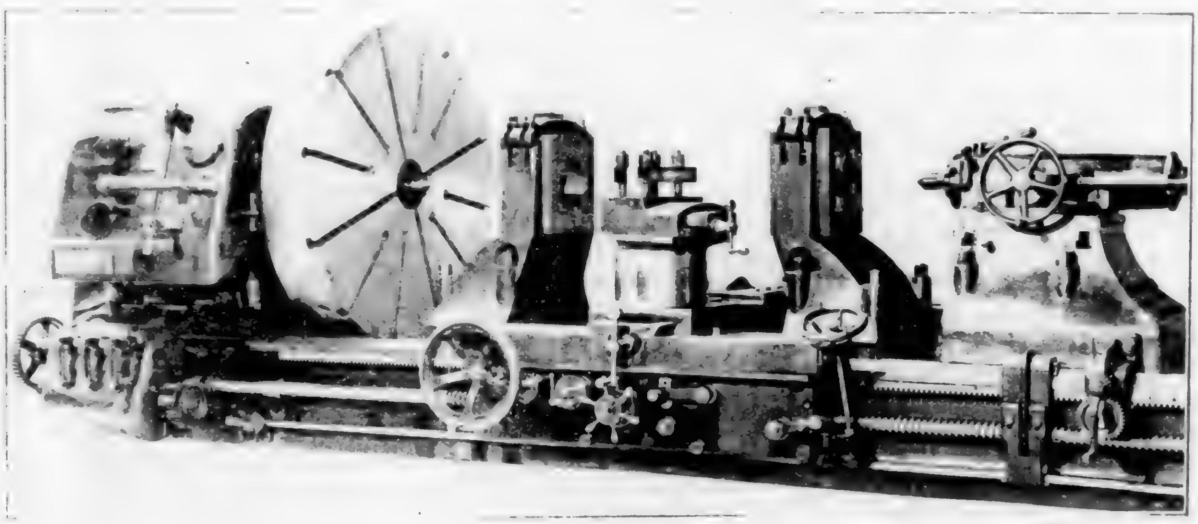

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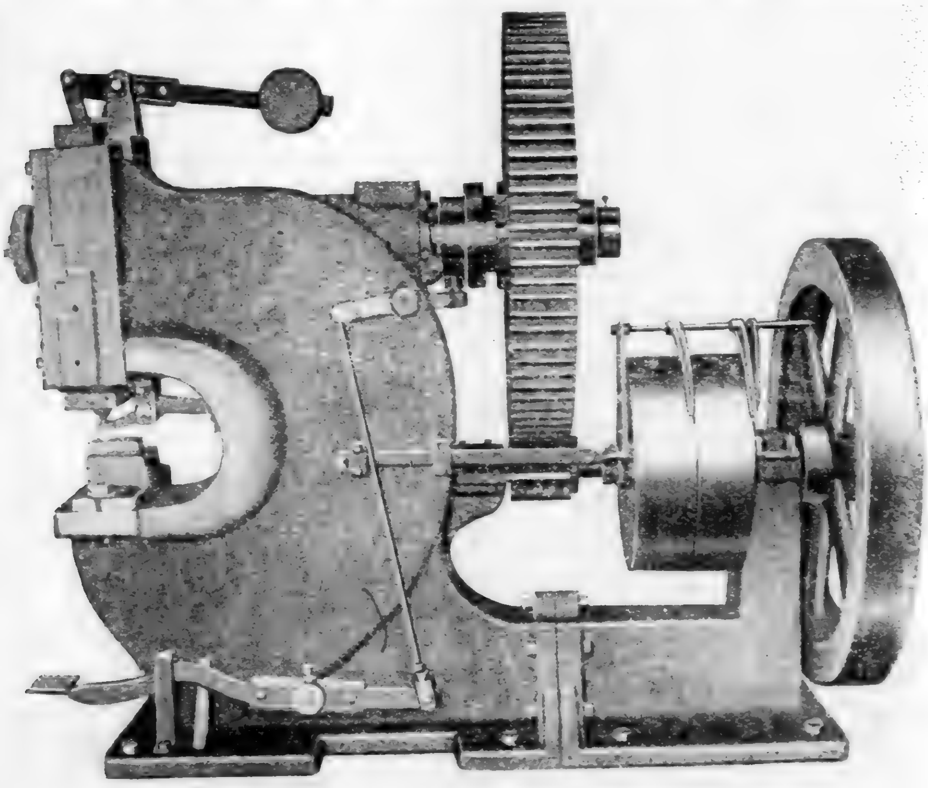
Speed of Steam Turbines.—High speed of rotation has been a rather serious drawback to the steam turbine as applied to marine practice. This has been overcome in designing the machinery for the new Cunarders, the turbines of which are expected to run at about 140 r.p.m. This appears to be an important feature of present development of the turbine for marine service.

Contributions to the Purdue Museum.—The New York, New Haven & Hartford Railway, through the courtesy of Mr. Samuel Higgins, general manager, has arranged to place in the care of Purdue University the historic locomotive, "Daniel Nason." This locomotive was built about 1858, and is one of the 8-wheel type, with cylinders inside the frames and cranked axles, which were common throughout New England 30 years ago. They are also placing in their keeping a stage coach passenger car which was put in service about 1835, and consists of the body of a stage coach suspended over a simple railway truck by means of braces.

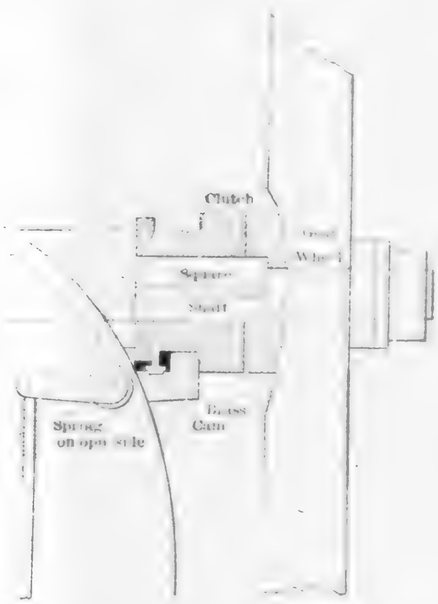
IMPROVED PUNCHING MACHINE.

The photograph and drawing illustrate a new positive adjustable stop as used in connection with an improved sliding clutch on a Cincinnati punch. By means of the adjustable stop the machine can be made to stop at either the top or bottom of the stroke or at any intermediate point. This is of special advantage for such work as exact center punching, as considerable time can be saved by having the punching tool automatically stop close to the work.

The mechanism which controls this is simple and consists of a brass cam fastened in the groove of the clutch and held in place by a bolt whose head fits in the deep slot to the left of the groove in which the clutch lever lug works. By loosening the nut on the bolt the cam can be set at any desired point on the circumference. As the cam comes in contact with the lug on the clutch lever, the clutch is thrown out and the machine is stopped. This makes a very simple and positive device.



CINCINNATI PUNCH, WITH POSITIVE ADJUSTABLE STOP AND IMPROVED SLIDING CLUTCH.



ADJUSTABLE STOP AND SLIDING CLUTCH.

The section of the driving shaft upon which the clutch slides is square, with the distance across the flats equal to the diameter of the round portion of the shaft. This obviates the use of keys or feathers which, because of the heavy intermittent stresses to which the shaft is subjected, are a source of annoyance, and it also greatly increases the strength of the shaft at what is ordinarily its weakest point. These devices are used on the punches and shears made by the Cincinnati Punch & Shear Company.

ENGLISH RAILWAY EQUIPMENT.—The railways of the United Kingdom at the close of last year owned 22,276 locomotives and 801,926 passenger carriages, wagons and other vehicles. In the total for England are included the following stock for lines worked by electricity, viz., 96 locomotives, 642 carriages and 19 other vehicles; and for Ireland the following stock for light railways, viz., 47 locomotives, 134 carriages and other vehicles attached to passenger trains, 497 wagons and 20 other vehicles.

A NEW FRANKLIN AIR COMPRESSOR.

The accompanying illustration shows one of the air compressors recently furnished the Pennsylvania Railroad at Altoona, Pa. They were designed and built by the Chicago Pneumatic Tool Company at Franklin, Pa., and belong to what they designate as their "C. S. C." class of machines, having compound steam cylinders and compound air cylinders. They are designed to run non-condensing with a boiler pressure of 100 lbs. The high and low pressure steam cylinders are 11 and 20 ins. in diameter respectively, and air cylinders 11 and 18 ins., with a stroke of 24 ins. The capacity of each compressor is 700 cu. ft. of free air at a speed of 100 r.p.m.

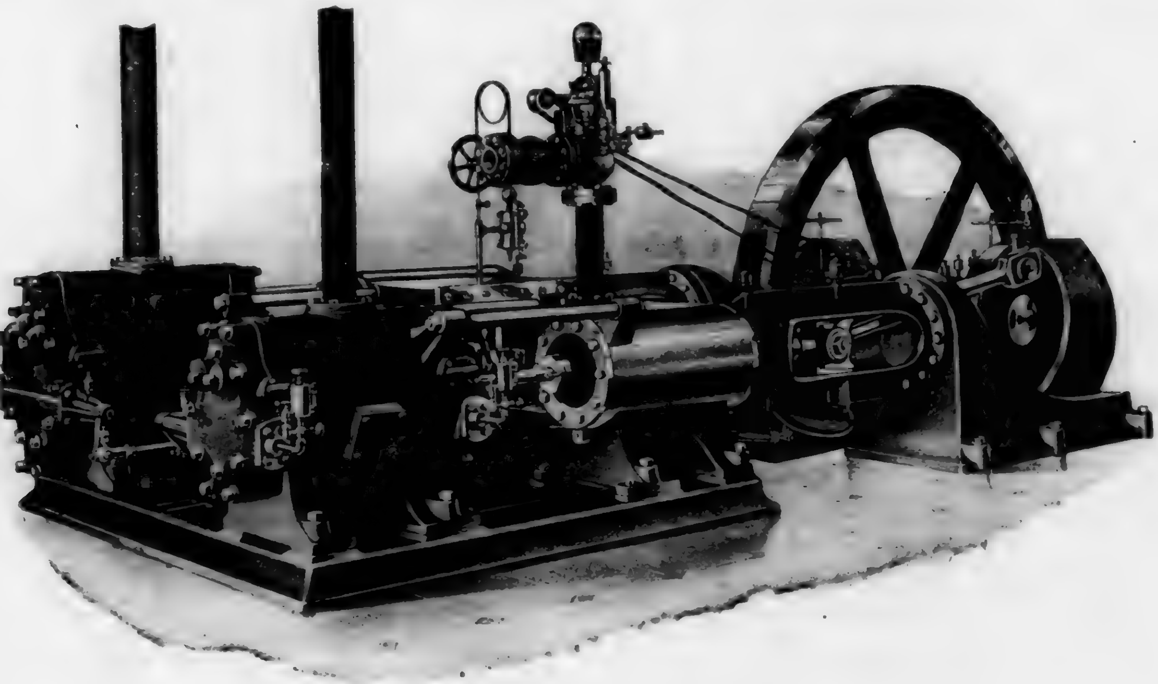
While graceful in outline, the machine is at the same time massive and compact. All bearings are of unusually generous proportions, the pressure per sq. in. being so reduced as to avoid any tendency to heating, a feature which will be appreciated by those who have had much experience with air compressors. The bearings throughout are provided with removable shells or bronze bushings, with simple but effective provision for taking up wear. The steam cylinders are provided with Meyer adjustable cut-off valves. The main steam valves are double ported, admitting of short ports and consequent reduction of clearance. The high and low pressure main steam valves are efficiently balanced, reducing friction and wear to a minimum. Both air cylinders are provided with mechanically operated inlet valves of the Corliss type, which are placed in the cylinder heads, admitting of close clearance and large port area, with consequent free admission of air. These valves are actuated by the steam cut-off eccentrics, so that four eccentrics drive both steam and air valves, the valve gear being very simple for the work performed. The discharge valves are of the poppet type, being of cup shape pressed out of sheet steel. The valve seats and guides are removable, and readily accessible for inspection or renewal.

An intercooler, not shown, is provided between high and low pressure air cylinders, which cools air after compression in the low pressure cylinder down to the temperature of the atmosphere. This intercooler, being self-contained, may be placed in any location desired. Owing to small bore of the cylinders and proportionately long stroke, the percentage of clearance in the air and steam cylinders is very small, resulting in high efficiency and economizing of steam. The water jacketing also is much more effective than in the compressors

of ordinary proportions, having diameters of cylinders about the same as length of stroke. Provision is made for catching all drip from stuffing boxes and bearings.

The governor is furnished with a pressure regulator, which brings the machine to a stop when the receiver pressure has reached a desired amount, starting it again automatically upon a slight drop in receiver pressure. The governor is also supplied with a safety stop, which will prevent the compressor from running away in case of accident to the governor belt. A rigid box section bed plate extends under the four cylinders to which they are securely doweled, a feature which is a great help in setting the machine and maintaining its alignment.

Further information may be obtained from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, or 95 Liberty street, New York.

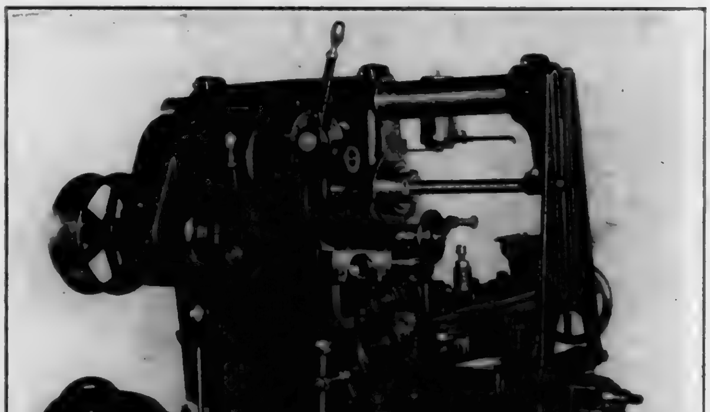


A NEW FRANKLIN AIR COMPRESSOR.

MOTOR DRIVEN MILLING MACHINE.

The photograph illustrates a motor drive applied to an improved Kempsmith universal milling machine. A $1\frac{1}{2}$-h.p., back gear type, constant speed Browning motor, made by the Northwestern Manufacturing Company of Milwaukee, is mounted on an extension which is rigidly bolted to the base of the machine. The back gear shaft of the motor may be connected to the driving shaft of the machine by either a wide belt or a silent chain. The motor application illustrated may be made at any time, but a more compact arrangement may be provided if it is incorporated in the machine while it is being built. Sixteen changes of spindle speed are provided. As these are obtained through ring frictions, the changes can be made while the machine is in motion without in any way interfering with its operation. The levers controlling these speed changes are within easy reach of the operator, who by referring to an index plate conveniently placed can readily determine the combination for the speed desired.

All feeds to the table are positive and automatic. The gear box, which contains a simple and powerful geared feed changing mechanism, is recessed into the column and is thus rigidly supported without any overhanging part. It is driven direct from the spindle by a sprocket chain. Through the levers shown on the gear box 16 changes of feed are available in geometrical progression, the range being selected for greatest efficiency in ordinary milling. An index plate on the front of the gear box shows the combination to obtain any desired feed. The levers for reversing all feeds and for automatically tripping all feeds at any time, are centrally located at the front of the knee, so that all movements of the machine are under the immediate control of the operator without changing his position.



KEMPSMITH UNIVERSAL MILLING MACHINE, MOTOR DRIVEN.

The column, base and bridge for the overhanging arm are cast in one piece with substantial internal ribs, which serve as tie plates for the sides of the column and also form a series of handy shelves. The swiveling table shown in the illustration is easily and firmly clamped at any position by an improved bevel clamping ring. The universal dividing head is simple and compact. The improved construction of the side

center tail stock allows the use of large diameter end milling cutters up to within 1/8 in. of the center. The center can easily be raised for milling tapers. The telescopic elevating screw permits the table to travel to its lowest point without requiring a hole in the floor or foundation. This machine is made by the Kempsmith Manufacturing Company of Milwaukee, Wis.

A NEW GENERATING SET.

In response to the growing demand for a high class generating set at a reasonable price, the B. F. Sturtevant Company, of Boston, Mass., are manufacturing a type illustrated by the accompanying engravings.

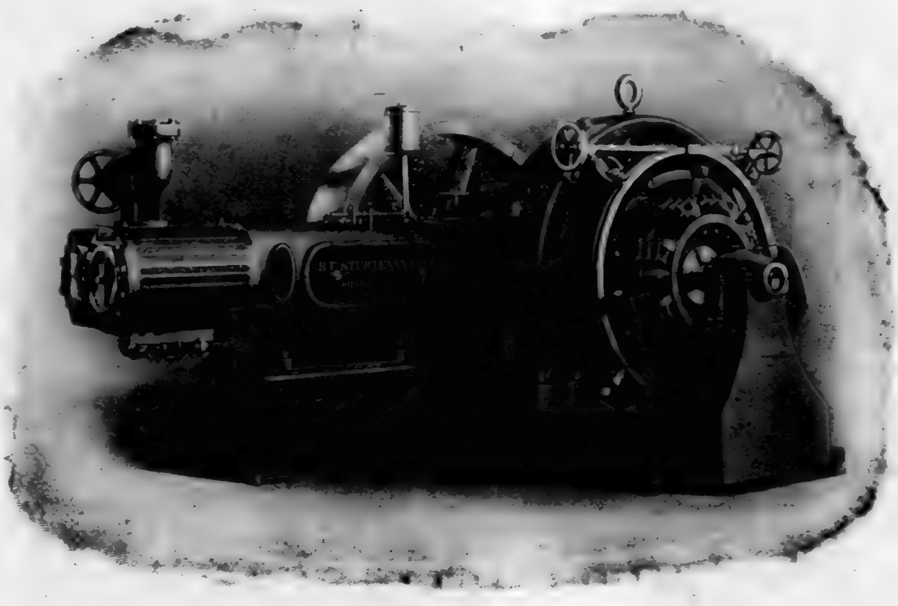
The general design of the engine embodies all the latest improvements to the horizontal type. The reciprocating parts are substantially constructed and counterbalanced with lead load discs. The crank shaft is forged solid in one piece and the discs are shrunk onto it. A special arrangement of the Rites' governor gives a regulation within 1 to 1½ per cent. from full load to no load, and by a modification of the Marshall valve gear an adjustment of the cut-off from zero to 70 deg. is attained. The main bearings, crank pins, valve stem and slides of this engine are well babbitted with the Sturtevant white metal. A recent and important improvement is a water shed partition which prevents water from the piston rod stuffing box from reaching the interior of the engine frame, and the oil on the reciprocating parts from being thrown out into the engine room. The main body of the engine is enclosed on both sides by removable plates, and the crank webs are enclosed by a cast iron hood having two holes with removable covers, one for the purpose of cleaning the crank pin box while it is in motion and the other for removing the box without taking off the large hood. Between the water shed partition and the front end of the cylinder is a hand hole for reaching the stuffing box bolts.

With the gravity or tank system of lubrication, shown in the illustration, an oil tank supplies the pipe leading to the parts to be oiled. At each point where the oil is delivered is a little gauge glass and valve for regulating the flow at that point. A valve just below the tank regulates the entire oiling system. With the pump, or forced lubricating system, a pump is located in the base of the engine and is operated by a crank shaft. Oil is delivered from this pump to the main bearings and from the main bearings through holes in the crank shaft and web to the crank pin. From this point the oil is conducted up through a hole in the connecting rod to the crosshead pin. A separate set of pipes convey the oil from the crosshead guides to the valve stem guides. The pressure of oil in the bearings under this system will vary from 12 to 18 lbs. per sq. in.

The generator of this set is of the eight-pole type, and is capable of carrying momentary overloads of 50 per cent. without any shifting of brushes or flashing of the commutator, and an overload of 25 per cent. for a period of two hours without undue heating. After a continuous run of ten hours at full load, the increase in temperature above that of the surrounding air never exceeds 40 deg. C. upon the armature and field coils, and 45 deg. C. upon the commutator. The average temperature rise is about 33 to 35 deg. C. Before being shipped, the generator is given a breakdown test of 1,500 volts, alternating for sixty seconds between the conductors and the frame of the machine, to test the insulation.

The magnet frame is the very best grade of cast iron, split horizontally. The pole pieces are of wrought iron, with cast iron shoes or horns, and are secured to the magnet frame by through bolts. Any of the pole pieces may thus be removed to repair the field coils. The latter are wound up in two sections, with an air space between the shunt and series coils. The shunt winding is of double cotton covered magnet wire, thoroughly insulated, and so treated as to be practically waterproof. The series winding is of solid copper bars, insulated in the same manner as the shunt coil. The armature is of the ironclad, form wound, ventilated drum type, having a core built up of charcoal iron plates, which plates, after being thoroughly japanned, are mounted upon a cast iron spider and securely held in position by end flanges. No bolts pass through the armature laminations. The armature spider has an extension upon which is mounted the commutator, making the armature and commutator one unit. The armature conductors are solid copper bars, without joints except at the commutator end. When these bars are formed they are insulated by material not perceptibly affected by heat or ordinary atmospheric moisture.

In the construction of the commutator, only drop-forged or drawn segments are used, these being secured in cast iron shell of spider construction, and clamped in place with a steel ring. No cast segments of any nature whatever are used. The segments are insulated with the best quality of carefully selected mica of a degree of hardness to allow the mica and segment to wear uniformly, obviating trouble from high mica. The end insulation consists of micanite rings, and the whole commutator is assembled while hot, under great pressure. Carbon brushes only are used, the commutator being so proportioned and the brushes of such size as to allow at least one square inch of brush area to every 30 amperes carried. These brushes are carried in holders of most approved construction, each mounted upon a self-contained brush rigging, so arranged that the entire set of brushes may be rotated completely around the commutator. Hand wheels are furnished for adjusting the brushes in position, these hand wheels being so located that the brushes may be adjusted from either side of the generator.



A NEW GENERATING SET.

SECOND TRACK ON SIBERIAN RAILWAY.—A recent report by Prince Hilkoff, minister of ways and communications in Russia, has led to the decision to lay a second track on the Siberian Railway to Lake Baikal. The Baikal Ring Railway and the Manchurian Railway are also to be double tracked, the total cost being estimated at 200,000,000 roubles, and the estimated time required two years.

AMERICAN RAILWAY APPLIANCE EXHIBITION.

The status of this enterprise, which is so important to the railway supply interests of this country, is admirably set forth in the following appeal by the general committee and the rules and regulations which have been established in connection with the exhibition:

APPEAL BY THE GENERAL COMMITTEE OF ARRANGEMENTS TO ALL CONCERNED.

GENTLEMEN:

The Congress of the United States, with the approval of the President, has signally honored the American manufacturers of railway appliances by the passage of an act permitting an exhibition of the products of their factories to be made on a part of the monument grounds in Washington, D. C., in connection with the meeting of the International Railway Congress, to continue from May 3rd to 14th, inclusive, 1905.

This gracious and generous compliment by the Federal authorities, which places at our disposal a central, convenient and conspicuous site for our exhibition, offers a supreme opportunity for the exploitation and exaltation of our craft. To improve it, is a duty; to neglect it, would be un-American.

The occasion will be unique in the annals of our industry. For a period of twelve days several hundred railway officials of high and important rank, representing many foreign countries, together with more hundreds of American railway officials of similar rank, will be gathered in Washington for the sole purpose of discussing railway problems.

In connection with this distinguished assemblage what could be more appropriate or important than an exhibition which shall show the fertility of resource, inventive genius, energy, enterprise and economic achievement of those who study with assiduity and with the zeal born of commercial ambition the requirements of railway operations.

The members of the American Section of the International Railway Congress are most anxious that the first meeting in America of the congress shall be a crowning success. As an adjunct powerfully conducive to such a success, the proposed American Railway Appliance Exhibition has their cordial approval.

Your committee appeals to the patriotic impulses and commercial acumen of our fraternity to make the proposed exhibition such a demonstration as shall command the interested attention of all railway officials, and cause to be known to the world what the American manufacturer has accomplished for the railways in solving some of their vexatious and pressing engineering and operating problems.

Your especial attention is called to the fact that the delegates to the International Railway Congress are being chosen from the executive, operating, mechanical and maintenance of way officials. All departments with which the supply men have dealings will be represented.

While the exhibition will offer exceptional advantages to those who seek export trade, it cannot be too forcibly stated that those who manufacture exclusively for American trade will have an opportunity to gain the attention of a larger number of American railway officials than has heretofore been enjoyed at any similar exhibition.

The director of exhibits has been authorized by the committee to invite applications for membership and for exhibit space under certain rules and regulations prescribed by the committee, which are fully set forth in the director's circular, and it is our earnest hope that the responses thereto will be prompt and in such numbers as shall show enthusiastic concert of action, and that a happy issue of our undertaking shall be quickly assured.

Again, you are reminded that the funds subscribed by you will be disbursed with due heed to proper economy, in keeping with such a great and dignified enterprise, and that no member of the committee or any officer thereof is to receive any monetary compensation for his services. It will be compensation enough for your servants on the committee if their efforts shall redound to the general welfare of the industry they seek to serve.

The fees for membership and for exhibit spaces have been fixed by the committee at figures to insure financial solvency beyond a peradventure. A deficit would be disgraceful, and must not occur; a surplus can readily be returned pro rata to those contributing, and would be so distributed.

Finally, the appeal is made for exhibits—fine ones, impressive ones. Anyhow, whether you exhibit or not, you are urged to enroll as members, as upon the fund raised from membership fees the proper and adequate administration of the exhibition and the entertainment of the visitors thereto depends.

Now, gentlemen, the preliminary arrangements and our appeal for co-operation having been made, the fate of the exhibition—its success or failure—rests with you.

Fraternally yours,

H. P. Bope, vice-president Carnegie Steel Co.; L. F. Braine, general manager Continuous Rail Joint Co.; A. E. Brown, vice-president Brown Hoisting Machinery Co.; J. B. Brady, vice-president Standard Steel Car Co.; O. H. Cutler, president American Brake Shoe & Foundry Co.; C. A. Coffin, president General Electric Co.; F. H. Eaton, president American Car & Foundry Co.; H. Elliott, Jr., vice-president Elliott Frog & Switch Co.; William Goldie, Sr., William Goldie, Jr. & Co.; F. N. Hoffstot, president Pressed Steel Car Co.; H. S. Hawley, president Railroad Supply Co.; A. B. Jenkins, Jenkins Bros.; Alba B. Johnson, Baldwin Locomotive Works; B. F. Jones, Jones & Laughlin Steel Co.; A. M. Kittredge, vice-president Barney & Smith Car Co.; W. V. Kelley, president Simplex Railway Appliance Co.; Geo. J. Kobusch, president St. Louis Car Co.; E. B. Leigh, vice-president Chicago Railway Equipment Co.; Wm. Lodge, president Lodge & Shipley Machine Tool Co.; General Charles Miller, president Galena-Signal Oil Co.; Charles A. Moore, Manning, Maxwell & Moore; Gov. Franklin Murphy, president Murphy Varnish Co.; D. C. Noble, president Pittsburg Spring & Steel Co.; Hon. H. Kirke Porter, H. K. Porter Co.; A. J. Pitkin, president American Locomotive Co.; Alfred A. Pope, president National Malleable Castings Co.; H. S. Paul, president Verona Tool Works; George A. Post, president Standard Coupler Co.; C. W. Sherburne, president Star Brass Mfg. Co.; C. A. Starbuck, president New York Air Brake Co.; W. W. Salmon, president General Railway Signal Co.; H. A. Sherwin, president Sherwin-Williams Co.; Albert Waycott, president Damascus Brake Beam Co.; H. H. Westinghouse, vice-president Westinghouse Air Brake Co.; W. W. Willits, vice-president Adams & Westlake Co.; J. Alexander Brown, secretary and director of exhibits—General Committee of Arrangements.

January 28, 1905.

FROM THE CIRCULAR OF THE SECRETARY.

Space will be assigned in the order of checks received by Mr. Charles A. Moore, treasurer. Access to the grounds for the erection of individual booths may be had on and after March 20. The exhibition building to be erected by the committee will be ready April 15. All communications concerning membership and space should be addressed to J. Alexander Brown, secretary and director of exhibits, 160 Broadway, New York.

RULES AND REGULATIONS.

Established for the guidance and the government of members and exhibitors in connection with American Railway Appliance Exhibition.

1st. All manufacturers of and dealers in American railway appliances, material and supplies are entitled to membership in the exhibition, upon the payment of a membership fee of $50. Those who are enrolled as members, and only those, shall be entitled to occupy space as exhibitors, but membership is not confined to those who propose to make exhibits.

2nd. Members shall be entitled to attend and participate in all ceremonies, functions and entertainments that may be arranged by the committee; to have issued to them a certificate of membership; to have their names printed in an official pamphlet to be published by the committee in connection with the exhibition stating the nature of their business and where located, and to receive such badges as may be designed by the committee to be worn by members during the continuance of the exhibition.

3rd. The committee will erect a large building for the housing of the smaller and lighter exhibits, similar to those displayed on the verandas during the mechanical conventions held annually in June. Spaces therein will be 10 feet in depth and 5 feet in width or the multiples thereof. A charge of fifty cents per square foot will be made for space occupied in this building.

4th. Exhibits to be operated by power, excessive in weight or requiring large space, necessarily have to be installed outside of the exhibition building erected by the committee, and the booths, pavilions or other structures in connection therewith will be erected by the exhibitors at their own expense. A charge of ten cents per square foot will be made for ground so occupied.

5th. A temporary track will be laid on B street, fronting the exhibition grounds, for the display of cars of the various types. The charge to be made per car will be announced at an early day.

6th. The ground to be occupied for the exhibition is a part of the government reservation in Washington, and its use is subject to restrictions prescribed by the secretary of war; therefore, it is to be expressly understood by the exhibitors that no excavations for foundations can be made, but all exhibit structures must rest upon foundations that may be laid upon the surface of the ground.

7th. Before any application for exhibit space shall be considered and space assigned, the applicant shall have first made application for membership, accompanied by check for fifty dollars, the membership fee, and the application for space shall be accompanied by check for the amount of space desired at the rate per square foot as prescribed in rules 3 and 4 hereof.

8th. It is to be expressly understood by and between the committee of arrangements for the exhibition and the exhibitors thereat that the said committee shall not be held liable under any circumstances for any loss or damage by fire, flood or other casualty, or by theft. The committee will arrange for such safeguarding of the exhibits as will, in their opinion, prove adequate during the continuance of the exhibition, but as the exhibition is not an incorporated body and the service of the committee and its officials is purely a voluntary and gratuitous one, in the interest of our great industry, its members, of course, will not be expected to assume any personal liabilities in connection therewith so far as exhibitors are concerned.

9th. According to the provisions of the joint resolution adopted by Congress, all structures erected upon the grounds for the purposes of the exhibition, must be approved by the officer in charge of public buildings and grounds before erection thereof can be begun, hence it will be necessary for exhibitors proposing to erect their own exhibit structures to submit plans therefor at the earliest possible date to the director of exhibits for such approval. As a general suggestion in regard thereto, such booths or exhibit structures should be of tasteful design, about 12 feet in height from the platform at the eaves, if covered, and of sufficient slope from the ridge pole to permit of proper drainage.

10th. The director of exhibits shall also approve of the size, design and location of all signs to be used for display purposes.

11th. It is also to be expressly understood by exhibitors erecting their own exhibit structures that such structures and the exhibits therein shall be entirely removed from the grounds prior to May 25th, 1905, as that is the date fixed by the Act of Congress when the right to use said grounds for exhibition purposes will expire.

12th. Steam and electric power will be placed at a central point, exhibitors to make their own connections and pay for the power used.

PERSONALS.

Mr. R. R. Young has been appointed master mechanic of the Atlantic Coast Line at Waycross, Ga., to succeed W. H. Dyer, resigned.

Mr. D. J. Timlin has been appointed master mechanic of the Rio Grande, Sierra Madre & Pacific, with headquarters at El Paso, Tex.

Mr. William Miller has been appointed assistant superintendent of motive power of the Denver & Rio Grande, with headquarters at Denver, Col.

Mr. William Bowden has been appointed master mechanic of the Terminal Railroad Association of St. Louis to succeed Mr. William Miller, resigned.

Mr. David Anderson has been appointed superintendent of equipment of the Chicago, Indiana & Eastern Railway, with headquarters at Muncie, Ind.

Mr. F. A. Deckert has been appointed master mechanic of the Riverside shops of the Louisville & Nashville Railroad, with headquarters at Knoxville, Tenn.

Mr. George W. Cooper has been appointed master mechanic of the Mexican Central at Monterey, Mex., succeeding Mr. T. H. Ogden, transferred.

Mr. S. A. Chamberlain, general foreman of shops of the Pere Marquette Railway, has been transferred from Ionia to Detroit, Mich.

Mr. W. C. Smith has been appointed master mechanic of the Missouri Pacific, with headquarters at Fort Scott, Kansas, to succeed Mr. W. L. Kellog, resigned.

Mr. J. B. Phillips, machine shop foreman of the San Bernardino shops of the Santa Fe, has been appointed general foreman of the locomotive shops, to succeed Mr. W. L. Essex, resigned.

Mr. J. F. Sheahan has been appointed master mechanic of the Southern Railway at Spencer, N. C., being transferred from Columbia, S. C., to succeed Mr. S. R. Richardson, resigned.

Mr. W. L. Kellog has been appointed master mechanic of the Pere Marquette, with headquarters at Grand Rapids, Mich., to succeed Mr. W. K. Christie, who has been transferred to Saginaw, Mich., as assistant master mechanic.

Mr. R. A. Billingham has been appointed superintendent of motive power of the Pittsburg, Shawmut & Northern Railroad, with headquarters at St. Marys, Pa. He was formerly general master mechanic, which position has been abolished.

Mr. F. A. Delano, general manager of the Chicago, Burlington & Quincy, has resigned. He has been in the service of this road for 20 years, beginning as apprentice at the Aurora shops and rising through both the operating and motive power departments.

James S. Toppan died in Chicago, January 8, at the age of 66 years. He was for a number of years Western manager of the Galena Oil Company, and through his efforts their large business in the West was built up. After leaving that company he represented a number of concerns in Chicago, and was one of the best-known railway supply men.

Mr. W. H. Baldwin, Jr., president of the Long Island Railroad, died January 3d and is mourned by many inside and outside of railroad circles. He was 41 years old and his remarkable career showed his phenomenal ability. He is succeeded by Mr. William F. Potter, formerly vice president of the road.

Mr. J. W. Marden has been appointed assistant master car builder of the Boston & Maine Railroad, with headquarters at Boston, Mass. Mr. Marden was heretofore general foreman of the car department.

Franklin David Child, formerly superintendent of the Hinkley Locomotive Works, of Boston, died at the Hotel St. Andrew, New York, on the evening of January 12. He was born in Boston, in 1843, and was thus sixty-two years old at the time of his death. Quite early in life he manifested a decided taste and aptitude for mechanics, and during his youth his leisure time was much occupied in the construction of mechanical contrivances of various kinds, which are so attractive to boys of that turn of mind. During the Civil War he enlisted in one of the nine-months' regiments which were organized in Massachusetts, and did service for that length of time in North Carolina. Soon after his term of enlistment expired, he entered the service of the Hinkley & Williams Works, which succeeded the old firm of Hinkley & Drury. He was at first draftsman there, and afterwards became the superintendent and manager. In that specialty he was a person of remarkable ability and ingenuity. This was combined with excellent judgment of the practicability of any form of mechanism, a combination of traits which is somewhat rare. After the death of Mr. Hinkley and Mr. Williams, the name of the company was changed to the Hinkley Locomotive Works, with Mr. Child as manager, and while the business was continued he transformed the locomotives which were built there from a somewhat antiquated pattern to a new one, which showed in marked degree the ability of the designer. After the failure of that company he was for a time employed as superintendent in the Providence Locomotive Works, and later in similar works in Kingston, Canada. During the past five or six years he was night superintendent of the great Baldwin Locomotive Works, in Philadelphia, and it was in that service that he contracted his last illness, which was a complication of diseases, and was quite suddenly fatal. He was of a rather retiring disposition, which, perhaps, stood in the way of his advancement, but was a delightful companion to those who knew him well; the soul of honor, a warm friend of those with whom he was in sympathy, and as an engineer, in his own specialty, he had few, if any, superiors. He left a wife and two daughters, to whom and his old and near friends his death is an irreparable loss.

Northern Pacific Official Appointments.—A number of appointments in the mechanical department of the Northern Pacific Railway are summed up as follows:

Mr. A. W. Wheatley, general master mechanic, St. Paul, Minn.

Mr. W. S. Clarkson, general master mechanic, Livingston, Mont.

Mr. William Moir, general master mechanic, Tacoma, Wash.

Mr. F. B. Childs, master mechanic, Spokane, Wash.

Mr. R. M. Crosby, shop superintendent, South Tacoma, Wash.

Mr. Thomas Jackson, shop superintendent, Livingston, Mont.

Mr. R. P. Blake, assistant shop superintendent, Brainerd, Minn.

Mr. J. E. O'Brien, assistant shop superintendent, South Tacoma, Wash.

Mr. C. S. Larrison, master mechanic, Dakota Division, Jamestown.

Mr. S. H. Draper, general air brake inspector, St. Paul, Minn.

Mr. Mark Purcell, assistant air brake inspector, St. Paul, Minn.

Mr. J. J. Davey, general boiler inspector, St. Paul, Minn.

Mr. G. F. Egbers, road foreman of engines, Spokane, Wash.

Mr. C. F. De Grat, road foreman of engines, Livingston, Mont.

Mr. L. A. Larsen, chief clerk, motive power department, St. Paul, Minn.

Mr. W. L. Kinsell, chief draftsman, St. Paul, Minn.

The shop and road responsibilities are separately provided for and much may be expected from such an organization.

Mr. J. P. Young has been appointed master car builder of the Missouri Pacific Railway, with headquarters at St. Louis, Mo.

Mr. John Fifer has been appointed master mechanic of the Chicago, Burlington & Quincy Railway, with headquarters at Des Moines, Ia.

William Sellers, president of William Sellers & Company of Philadelphia, died January 24 after a surgical operation. He was born in 1824 in Pennsylvania, and spent his entire business career in the manufacture of steel and machine tools, being the founder of the company which bears his name. In 1873 he was president of the Midvale Steel Company.

BOOKS.

Engineers of America.—A directory and biography of the engineers of America is in preparation by Mr. Ernest C. Brown, publisher of the Progressive Age, 220 Broadway, New York. The proposed volume will present brief biographies of about 3,000 engineers, and it is the intention to record only the names and life work of men who have become prominent by their accomplishments in engineering. This volume will soon come from the press. The work promises to be unique and valuable to the engineering profession.

The Mechanical World Pocket Diary and Year Book for 1905. Published by Emmet & Company, publishers of the *Mechanical World*, New Bridge street, Manchester, England.

This is the eighteenth annual edition of this convenient little book. Its size is increased this year by the addition of a table of trigonometrical ratios and formulæ and other tables of squares, cubes and fourth powers of fractions, a collection of powers, roots and reciprocals of factors often desired by engineers. The matter on ball bearings has been revised and other sections enlarged.

Business Short-Cuts, in Accounting, Bookkeeping, Correspondence and Management. Published by The Bookkeeper Publishing Company, 61 West Fort street, Detroit, Mich. Price, $1.00.

This little book has many good points and contains valuable suggestions for chief clerks and bookkeepers of railroads, as well as other lines of business. The various chapters are taken from different issues of the *Bookkeeper and Business Men's Magazine* and are thrown together without any attempt at classification. The book is worth the price for its suggestions concerning card indexing alone, if it had no other good points.

Untechnical Addresses on Technical Subjects. By James Douglas, LL.D. Published by John Wiley & Sons, 143 East 14th street, New York. 1904. Price $1.00.

This little book contains three interesting addresses on the following subjects: Characteristics and Conditions of the Technical Progress of the Nineteenth Century, Development of American Mining and Metallurgy and the Equipment of a Training School, also Wastes in Mining and Metallurgy. The subjects are treated in a popular style, being in phases of progress lying within the zone of sociology. The author urges the importance of free interchange of experience in a true professional spirit and argues forcibly against the wasteful effects of secrecy. He outlines the wonderful progress of the past century, which is a result of a spirit of originality and comments favorably upon the independence of American manufacturers in introducing improvements of all kinds. The book wil specially interest those who are concerned in metallurgical manufacturing.

Illustrated Points for Men on the Head End. By W. G. Wallace. Illustrated and published by the World Railway Publishing Company, 79 Dearborn St., Chicago, Ill. Price $1.00.

This little book contains a large amount of information for locomotive engineers and firemen, condensed in a very small space. The author is superintendent of motive power of the Duluth, Missabe & Northern Railway and from the appearance of the book it is believed to have been gotten up for distribution among his subordinates, and afterwards published for wider distribution. It does not cover enough of the features of locomotive operation to be a complete work, but gives valuable suggestions with reference to such subjects as the arrangement of locomotive front ends in order to secure good steaming qualities; water level is discussed and its relation to operation. Valve gear receives special attention; also adjustment and lubrication. The latter portion of the book contains rules and data issued by the Baldwin Locomotive Works for figuring tractive power.

Fowler's Electrical Engineer's Year Book, 1905. Published by the Scientific Publishing Company, Manchester, England. Price in England, 1 shilling, sixpence.

This very valuable handbook has been brought up to date and considerable new material has been added to the various sections.

Dimensions of Pipe, Fittings and Valves. By W. D. Browning. 82 pages. Published by The Draftsman, 204 Superior street, Cleveland, Ohio, 1904. Price 50 cents.

This book was compiled to aid the draftsman, architect and engineer and contains over 50 tables of dimension, nearly all of which are from actual measurement, although some are taken from catalogues. In addition it contains some useful information on steam heating. The book has been very carelessly edited and the inaccurateness of the text lead one to mistrust the tables. The publishers should issue a revised edition, as this information if correct, would prove of much value to engineers.

National Railroad Master Blacksmiths' Association Proceedings of the 12th Annual Convention. Edited by the Secretary, A. L. Woodworth, Lima, Ohio.

This volume contains reports and discussions of the Indianapolis meeting held last August. The most important subjects were spring making, tool steel forging and tempering, selection and testing of material, material for forgings, the ideal blacksmith shop (a paper by Mr. McCaslin), the making and repairing of locomotive frames, alumino-thermics, oil furnaces, formers for bulldozers, frame welding, and other important matters relating to the blacksmith work on railroads. This association is doing excellent work which entitles it to more attention from railroad officials than it has thus far received.

Handbook of Builders' Hardware. A Handbook for Architects. By Henry R. Towne, president of the Yale & Towne Manufacturing Company. 1,072 pages, 4 x 6½ ins. Published by John Wiley & Sons, 43 East 19th street, New York. Price $3.

This book is unique. It is not an advertisement or catalogue, but a volume on builders' hardware as related to the architect and architecture. It is profusely illustrated; it contains a historical review and deals with many designs and forms of fine hardware. A series of articles on schools of ornament by Mr. W. W. Kent are illustrated with pictures from many sources which will be valuable to the architect. Scales of prices, lists of hardware and other features of service to the architect are included. The author frequently refers to the product of his company in this technical treatise on his subject.

Mechanical Railway Signaling. By H. Raynar Wilson, late signal engineer of the Lancashire & Yorkshire and the Mildand railways (England). Published by the *Railway Engineer*, 3 Ludgate Circus Buildings, London, E. C., England. 193 pages (9 by 12 ins.), illustrated. Price $5.

This is the second edition of this admirable work; the first appeared in May, 1900. Its chapters are: Introduction, single lines, signal boxes, signals, signal and point connections, locking frames, signal plans and locking lists, level crossing gates, large signal plants, the signal department, Board of Trade requirements and standard specifications for signaling works. It is devoted to English practice, and there is no work on signaling as good as this. The author really takes the reader into the heart of signal practice and presents working drawings of the elements employed and the buildings used, and goes into detail as no other signal authority has ever done. No American signal engineer can afford to be without this book as it is a record of practice in a country where railroad signaling is appreciated and is reduced to an exact science.

Elements of Mechanism. By Peter Schwamb, Professor of Machine Design, and A. L. Merrill, Associate Professor of Mechanism, Massachusetts Institute of Technology. 264 pages, 6 x 9 ins., illustrated. Published by John Wiley & Sons, 43 East 19th street, New York. Price $3.

This excellent book is the result of a demand outside the Massachusetts Institute of Technology for the notes used in the mechanism course so successfully by Professor Schwamb. The authors do not claim originality, but the merit of the book is that it renders it possible to cover a great deal of ground in a short time. In clearness it surpasses all other books on this subject with which the reviewer is familiar. The book opens with the elements of motion and velocity. Pairs of elements, rolling cylinders, cones and lobed wheels are followed by belts, levers, links, parallel motions, wheels in trains, aggregate combinations and gearing. The book is intended for use in schools, but is well adapted to the independent student.

LETTERS FROM AN OLD RAILWAY OFFICIAL TO HIS SON, A DIVISION SUPERINTENDENT.—By Charles De Lano Hine. Chicago: The Railway Age, 5 by 7½ ins., 179 pages. Price, $1.50.

In these letters to his "son" the author reaches the difficulties of many men in all branches of railroad service. The plan would be audacious in the hands of any but a master; but Major Hine is a master. This strong book will surely exert an influence over many men in railroad service. It amuses while it instructs and the author's style is exactly suited to his object. It is breezy, bright, virile and humorous. Major Hine is on the staff of the second vice-president of the Burlington system. He knows his subject and he understands men. The book will be read with profit by the president and the office boy. It will tend to turn the wheels out of the ruts. In the letters all branches of the operating department receive critical attention and many opportunities for improvement are pointed out with a fearless directness and yet in a pleasing way. Railroad language is used with telling effect. Not only operating, but other officers and subordinates in all departments, will receive inspiration from this book.

Tests Upon Reinforced Concrete Beams. By Arthur N. Talbot. Bulletin No. 1 of the University of Illinois Engineering Experiment Station.

The tests described at length in this bulletin furnish a valuable addition to our knowledge of the action of reinforced concrete beams, and the thanks of the engineering profession are due to Professor Talbot for the thoroughness with which the experiments were made and the results presented. Especially valuable are the data given upon the location of the neutral axis under varying loads since all formulæ for the strength of such beams must be based upon its position and although other careful experimnts to determine this have been made, so far as we are aware none have yet been published in such complete detail. One of the interesting points to be noted in connection with these tests is that all the beams failed at the center through bending rather than at the ends through tension at 45 deg. to the neutral axis. These results do not agree with certain other experiments upon such beams, notably those made by Professor Lanza at the Massachusetts Institute of Technology and described in Vol. L of the Transactions of the American Society of Civil Engineers. The reason for this difference in the method of failure might well be studied by future experimenters.

CALENDARS FOR 1905.—Calendars have been received from well known concerns as follows: The Standard Tool Company have distributed a calendar on the back of which is a very convenient collection of tables, of special value to users of machine tools in connection with twist drills, milling cutters and other tools. This gives sizes of twist drills, speed for various materials, size of sockets, standard threads and cutting speeds for milling machines, shapers and lathes. This calendar will be in special demand and readers desiring them would do well to make their request for copies early.

The Falls Hollow Stay Bolt Company, Cuyahoga Falls, Ohio, have issued one bearing a well executed picture which will be specially appreciated by fishermen who may have mistaken movements of the rod, due to the activity of a small dog, for the vigorous bite which is so dear to the heart of an ardent angler.

The Kennicott Water Softener Company have distributed an exceedingly handsome reproduction of a picture entitled "Marcelle" by Angello Asti. It is a beautiful work of art.

The Triumph Electric Company's calendar is very attractive and presents the same work of art as that of the Kennicott Water Softener Company, with a difference in the coloring.

The Cleveland Pneumatic Tool Company of Cleveland, Ohio, have sent out two exceedingly handsome calendars in colors which are unique in this branch of advertising.

Another by the Universal Safety Tread Company, 45 Broadway, New York, illustrates safety treads as applied to locomotive steps.

SUBJECTS FOR THE TRAVELING ENGINEERS' ASSOCAITION.—At the next meeting of the Traveling Engineers' Association the following subjects will be discussed: 1. Is a third man necessary on large locomotives? 2. Grease as a lubricant for all locomotive bearings. 3. Devices and arrangement of engines and tenders to lighten the work of the engineer and fireman. 4. Care and arrangement of bell ringers, air sanders and other devices operated by compressed air.

Papers will be received on electric motors, injectors, lubricants, mechanical stokers and piston valves.

Wanted—Complete volumes of this journal, unbound, for the years 1896, 1897, 1898 and 1899. Address the Editor, AMERICAN ENGINEER, 140 Nassau street, New York.

NEW CATALOGUES.

IN WRITING FOR THESE CATALOGUES PLEASE MENTION THIS PAPER.

WOODWORKING MACHINERY.—Catalogue No. 21 from the Frank Machinery Company of Buffalo, N. Y.

CRANES.—Illustrated catalogue of the various cranes designed and constructed by William Sellers & Company, Philadelphia, Pa.

PIPE THREADING AND CUTTING OFF MACHINES.—Circulars from the Stoever Foundry & Manufacturing Company, Myerstown, Pa.

DE LAVAL STEAM TURBINE ALTERNATORS.—Bulletin No. 3 from the De Laval Steam Turbine Company, Trenton, N. J.

AIR COMPRESSORS.—Catalogue No. 36 from the Ingersoll-Sergeant Drill Company, 26 Cortlandt street, New York.

DYNAMOS AND MOTORS.—Bulletins from the Commercial Electric Company, Indianapolis, Ind.

LOCOMOTIVE COALING CRANES.—Catalogue from the Brown Hoisting Machinery Company, Cleveland, Ohio.

DIRECT CURRENT MOTORS.—Bulletin No. 1 from the Burke Electric Company, Erie, Pa., describing their AB type motors.

PULLEYS.—Circular describing the pressed steel pulleys made by the Phillip's Pressed Steel Pulley Works, Philadelphia, Pa.

POWER TRANSMISSION APPLIANCES.—Catalogue No. 18 from the Case Manufacturing Company, Columbus, Ohio.

FRICTION CLUTCHES.—Booklet C from the Carlyle Johnson Machine Company, Hartford, Conn.

INSPIRATORS.—Pocket edition of the large catalogue issued by the Hancock Inspirator Company, 85 Liberty street, New York.

MOTORS AND GENERATORS.—Bulletin 3055 from the Western Electric Company, 463 West street, New York, describing their encased, protected and semi-encased motors and generators.

INTER-POLE VARIABLE SPEED MOTOR.—Bulletins 1, 2 and 3, series "B," from the Electro Dynamic Company, Bayonne, N. J., describing this motor and illustrating applications to various machine tools.

MOTOR DRIVEN FRICTION AND BENCH DRILLS.—Bulletin No. 3061 from the Emerson Electric Manufacturing Company, St. Louis, Mo.

"RING TURRET" LATHE.—Catalogue from the Walter H. Foster Company, 126 Liberty street, New York, describing this interesting lathe.

ARC LAMPS.—Bulletins 7030, 7035 and 7040, issued by the Western Electric Company, New York, describing arc lamps for direct and alternating current circuits.

UNIVERSAL CUTTER AND TOOL GRINDER.—Circular from the Oesterlein Machine Company, Cincinnati, Ohio, describing their No. 2 machine.

INJECTORS.—A pocket edition of the catalogue describing the Metropolitan injectors made by the Hayden & Derby Manufacturing Company, 85 Liberty street, New York.

HYATT FLEXIBLE ROLLER BEARINGS.—Bulletin No. 116 from the Hyatt Roller Bearing Company, Harrison N. J., presenting a report on power saved by substituting their bearings in place of ring oiling babbitted bearings.

MULTI-SPEED MOTORS.—Bulletin No. 45, issued by the Northern Electrical Manufacturing Company of Madison, Wis., describes their new multi-speed motor, explains the ease with which it can be applied to old belt-driven machine tools, and considers the advantages to be gained by its use.

OIL SWITCHES AND OIL CIRCUIT BREAKERS.—The Westinghouse Electric & Manufacturing Company of Pittsburg are about to distribute Circular No. 1,096, which describes and illustrates the various types of oil switches and oil circuit breakers made by them. These include high tension oil circuit breakers designed for pressures as high as 60,000 volts.

WESTINGHOUSE DIARY.—A convenient vest pocket diary has been issued by the Westinghouse Electric & Manufacturing Company. In addition to the diary itself and the information usually contained in books of this kind, it has about forty pages of valuable engineering data which will be appreciated by engineers, especially those interested in electric and steam practice. It is the best book of its kind that we have seen.

PRECISION TOOLS.—A handsomely illustrated and printed cloth bound book of 216 pages, with the above title, describes the products of the Pratt & Whitney Company, and is just about to be issued by the Niles-Bement-Pond Company. The first part of this book is devoted to machine tools, which include bench, tool makers, engine and turret lathes; automatic screw machines; shaping, milling, profiling, thread-milling, die-sinking and gear-cutting machines; sensitive and multi-spindle drills; grinding, tube and gun barrel drilling, rifling, centering, cutting-off, roll grooving, tapping, and screw shaving machines; rotary oil pumps and chucks. The second part of the book is devoted to small tools and gauges, which include taps, die-stock sets, milling cutters, metal slitting cutters, reamers, mandrills, taper pins, ratchet drills, punches, punch couplings, standard dies, gauges of all kinds and standard measuring machines.

NOTES.

KENNICOTT WATER SOFTENER COMPANY.—Mr. W. R. Toppan, who has held the position of manager of the railroad department of this company since its organization, has been elected general manager, with headquarters in the Railway Exchange Building, Chicago.

Mr. A. E. Ostrander has been appointed assistant mechanical engineer of the American Car & Foundry Company, in charge of the designing work, at the general offices in New York, which has formerly been done at Berwick, Pa. Mr. Ostrander has been engaged in estimating and special designing, and was formerly employed by the Standard Steel Car Company of Pittsburgh. He will report to Mr. John McE. Ames, mechanical engineer.

CONTINUOUS RAIL JOINTS.—The Illinois Steel Company is about to begin an extension of its works at Joliet, Ill., at a cost of one hundred thousand dollars ($100,000.00) to accommodate the business of the Continuous Rail Joint Company of America. The latter company is a New Jersey corporation with headquarters at Newark, N. J. It has extensive works at Troy, N. Y., but its western business requires a plant nearer the center of that trade and for this reason the arrangements noted above have been made with the Illinois Steel Company.

FARLOW DRAFT GEAR.—This gear will be applied to 1,000 steel hopper coal cars of 50 tons capacity which are being built for the Delaware, Susquehanna & Schuylkill Railroad by the Pressed Steel Car Company. This gear was illustrated in this journal in September, 1904, and a remarkable test, made at Purdue University, was recorded in the December number, page 482. The Farlow Draft Gear Company will remove, February 1, from temporary quarters at 223 North Calvert street to the Continental Trust Building, Baltimore street, Baltimore, Md.

BRODERICK & BASCOM ROPE COMPANY.—This company, whose exhibit at the Louisiana Purchase Exposition has been mentioned in this journal, received at that exposition five highest awards in all. The grand prizes were for wire ropes in Mines and Metallurgy Building, for wire ropes in the Manufacturers' Building and for underground wire rope haulage. This is the only firm of all the exhibitors in the Manufacturers' Building receiving a grand prize for the excellence and superiority of wire rope. The address of this company is 805 North Main Street, St. Louis, Mo.

CINCINNATI PLANER COMPANY.—The Cincinnati Planer Company of Cincinnati, Ohio, have increased their capital stock to $200,000, and elected the following officers: C. H. M. Atkins, president; B. B. Quillen, secretary and treasurer; George Langen, general superintendent. These officers, together with E. N. Atkins and C. M. Quillen, make up the directory. W. H. Burtner, former president of the company, retires on account of poor health. Mr. Atkins, the new president, is also president of the Warner Elevator Company and the Norwood National Bank, and is connected with several other leading concerns of Cincinnati.

MONARCH RAILWAY SUPPLY COMPANY.—This company has been organized to handle railway specialties, with Mr. Harry W. Frost as president and with headquarters at Detroit, Mich. Arrangements have been made with the Pressed Steel Car Company for the sale of their trucks, bolsters, brake beams and steel carlines. In addition to these specialties, the company will go into the manufacturing business. One article of manufacture will be the Daly railway spikes, which will be placed upon the market about March 1. The temporary offices of the company are in the Majestic Building, Detroit, and permanent offices will be located in the Penobscot Building after May 1, 1905.

TURBO-GENERATORS FOR TRACTION WORK.—The Westinghouse Electric and Manufacturing Company has sold to the Syracuse Railroad Construction Company apparatus for the complete equipment of the Rochester, Syracuse & Eastern Railroad. The contracts include 2 1,500-kw. turbo-generator outfits which will generate current at 3,300 volts, 3-phase and 25 cycles. Each turbo generator will be furnished with a 50-kw. exciter mounted on the turbine shaft. The equipment also includes 2 500-kw. rotary converters and 6 400-kw. rotary converters; 24 transformers, with a total capacity of 6,500 kw., a 13-panel switchboard for the main generating station, and 3 sub-station switchboards of 5 panels each as well as protective and detail apparatus. Motor equipments included in the contract call for 12 quadruple equipments of Westinghouse 110-h.p. motors, as well as 8 quadruple and 2 double equipments of motors of other sizes.

MANNING, MAXWELL & MOORE.—Mr. Charles A. Moore announces that he has purchased the entire interest of Mr. Henry S. Manning in the firm of Manning, Maxwell & Moore, together with his interest in the various manufacturing concerns, viz.: The Ashcroft Manufacturing Company, The Consolidated Safety Valve Company, The Hayden & Derby Manufacturing Company and The Hancock Inspirator Company. There will be no change in the name of the firm and its business will continue to be conducted as in the past. The firm now has branch offices in Chicago, Cleveland, St. Paul, Pittsburgh, Boston and Philadelphia. Various interests have been acquired, so that at present the firm is interested in the manufacture of steam gauges, indicators, pipe fitting tools, safety valves, injectors, ejectors, Hancock inspirators, various kinds of valves and electric traveling cranes. In addition to these the firm handles railway and machinists' tools and supplies, air compressors, pneumatic hoists, riveters, and complete machine shop and foundry equipment. The offices will continue at 85 Liberty St., New York.

ARTHUR M. WAITT.—Mr. Waitt has opened an office in the Whitehall Building, 17 Battery Place, New York, as a consulting engineer and railway specialist. He will devote his efforts in the direction of railroads, having been closely associated with mechanical railroad problems for 25 years. His services are available in a consulting capacity by railway or other companies desiring expert advice in mechanical department matters, or in investigating and developing mechanical devices or patents. His years of experience in the mechanical departments of the Lake Shore and the New York Central railroads have been supplemented by extensive study and personal observation, both in Europe and in the United States, in the application of heavy electric traction as a substitute for steam. This prepares him to act in a consulting capacity for railway companies contemplating the electrification of parts of lines of railways. He is also prepared to act in the selection and purchase of railway supplies for companies desiring an experienced representative in such matters in New York. Mr. Waitt's experience, energy and business capacity will render his services exceedingly valuable to the railroads.

THE FALLS HOLLOW STAY BOLT.—Several thousand feet of double refined charcoal iron hollow bar have been ordered from the Falls Hollow Stay Bolt Company, Cuyahoga Falls, Ohio, by the Baldwin Locomotive Works for use in a number of locomotives which are being built for export to Brazil. These stay bolt manufacturers are receiving orders from many foreign countries. The volume of business with Canadian and Mexican railroads for 1904 was double that of 1903. The increase of business has necessitated a large addition to the plant during the past year, including buildings, heating furnaces and other facilities which have doubled its capacity.

WANTED—POSITION AS SALESMAN.

A gentleman "who can reach the railroad men," steam and electric railroads, and who has a large trade among railroads, car ship, locomotive and bridge builders, will be open to engagement after February 1st as traveling salesman in any line of goods demanded in those markets; has been specially successful in introducing novelties that reduce the cost of operation; can offer first class references from among his customers as to his abilities and standing among them. Address H. H., care of Editor of AMERICAN ENGINEER.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

MARCH, 1905.

CONTENTS.

PRODUCTION IMPROVEMENTS.

CHICAGO SHOPS—C. & N. W. RAILWAY.

A repair shop which has turned out 50 locomotives with general repairs from 21 pits in one month is entitled to high rank, not only among railroads, but commercial establishments. These shops have done this and they are turning out regularly upwards of 40 locomotives per month. This is an old shop, built over 30 years ago and without crane service except in the boiler shop. (AMERICAN ENGINEER, April, 1900, page 111). These shops constitute an admirable example of improvement, showing the possibilities of a definite policy of renewing machine equipment in an old plant, partially rebuilt 4 years ago, and operated throughout on a day rate basis.

In February, 1904 (page 58), this journal illustrated the shop schedule for repairs which has been the means of reducing delays incidental to waiting for material. The first schedule was put into effect in November, 1902, and it classified repairs as follows: Class 1. General repairs, including fireboxes (half side sheets and a flue sheet being equivalent to a firebox). This required 240 hours. Class 2. General repairs with half-side sheets, 210 hours. Class 3. General repairs, including a back flue sheet, 160 hours. Class 4. Heavy repairs, without new firebox sheets, 120 hours. Since its inauguration the schedule has been reduced as follows: Class 1 to 220 hours; Class 2 to 170 hours; Class 3 to 130 hours, and Class 4 to 100 hours. Therefore at the present time the average time of a locomotive in the shop for all classes of heavy repairs is 15.5 days.

One factor in this improvement is the meeting of all the shop foremen, which is called at 10.30 every Monday morning. Statements of the condition of work in the shop (see form, AMERICAN ENGINEER, February, 1904, page 58) are ready for this meeting and each locomotive is discussed in detail, and delays and expected delays are brought to light and provided for. In this way the work on one engine may be advanced to take the place of other work which is delayed. None of the foremen like to see their work on the delayed list and they look forward in every possible way to insure having material and parts ready when wanted. In the month of January, 1905, one foreman having 5 pits turned out 9 engines, another with 4 pits turned out the same number. Two of the other 3 foremen with 4 pits each turned out 8 and the fifth turned out 7 engines.

In order to keep the men out of each other's way, a night gang of 2 boiler makers and 2 helpers is used to hasten delayed work. Two other men work at night on ash pans and front ends. These men can work without interference with the other gangs because they have the engines to themselves. All stripping is done under the big crane in the boiler shop and the work is distributed from there. The lye vats are located between the boiler and erecting shops and the work halts on its way across. In case a locomotive is delayed when nearly finished it is moved out of the shop and waits in the boiler shop, or out of doors instead of occupying more valuable space in one of the shop pits.

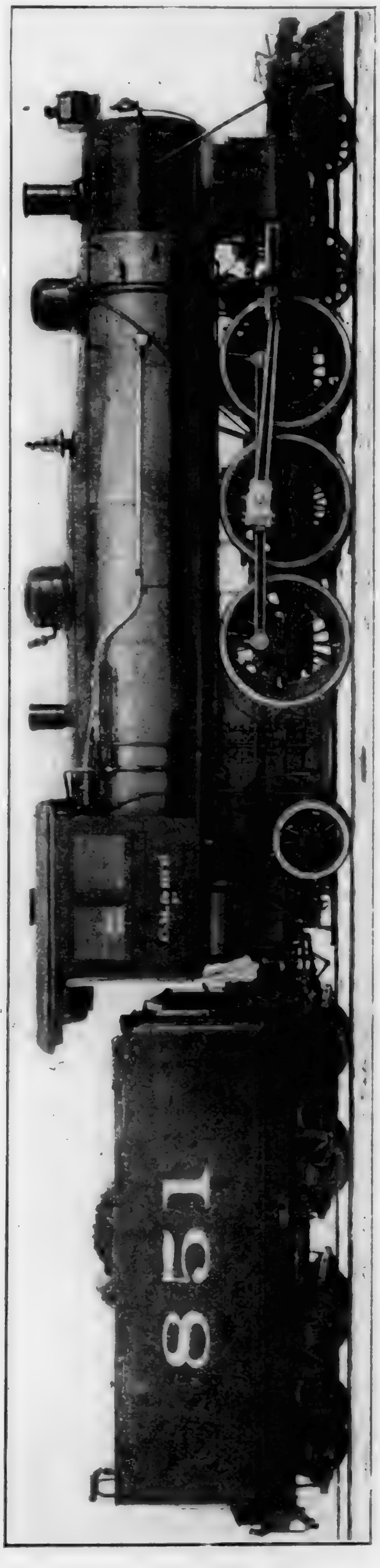
These shops were extended early in 1900 and additional facilities were provided, which have been described in this journal (reference already given). Since then the machine tool equipment has been continually improved, and this work is going on steadily. Whenever a new machine is available which will increase the output after the old machinery has been brought up to its limit the old gives place to the new. This method develops the old equipment and puts the organization in position to secure the full advantages of improvements. About two years ago the line shafting was speeded up from 120 to 150 r.p.m. by changing the motor pulleys, the motors being of sufficient capacity to render this possible. Six months ago it was again speeded up to 200 revolutions.

The wheel lathes supply an excellent example of the shop output. A Niles lathe of light construction, about 4 years old, has received special attention and by using improved tool steel and better appliances for handling wheels, together with better methods of driving the wheels in the lathe, a considerable increase in output has been secured. For instance, the driving dogs are placed near the rim of the wheel and the chattering is reduced. The slides have been cut away next to the face plates so that the driving dogs will clear and adjustable dogs are used, permitting the bearings of all to be made alike. This is important in working on large driving wheels.

This work is done at slow cutting speeds of from 12 to 14 ft. per minute. Heavy feeds are used and but one cut is taken over a tire, with a feed varying from ⅛ to 3-16 in. according to the condition of the tire as to wear. Tires are left rough on the tread without a finishing cut. It has been found possible to remove more material by the slow speed and heavy feed than by high speed and light feed. Only the best tool steels are used. Formerly a gauge was employed to get the correct height of the flange. Now the tool post screw is turned a certain number of times. By knowing the pitch of the screw the standard height of flange is secured without measuring. Every minute counts on this work. The operator changes the position of the tool as little as possible and he uses the same tool for facing the tread and roughing both sides of the flange, this being a right and left hand roughing tool. A forming tool finishes the flange on both sides at once. One and a quarter in. square tool steel is used for the tools and these are held in holders.

An average result for 20 days' work was 3.4 pairs of drivers in 9 hours, with wheels varying from 52 to 74 ins. in diameter. About the same time is required for small as for large wheels, as the small ones are usually badly worn. Before these improvements were introduced 4½ hours per pair was considered good work.

Among the factors contributing to the high standing of this plant is a cost keeping system, whereby the actual cost of each portion of the work is kept and the records are very carefully watched. It is very apparent in going through this shop that a great deal of lost motion has been eliminated. It is crowded and with a very old building work is turned out, because of organization and methods, which is not at the present time matched in any of the larger and more modern shops which the writer has visited. This is very creditable to Mr. Quayle, superintendent of motive power; Mr. H. [illegible] Bentley, assistant superintendent of motive power, and M[illegible] Otto, general foreman.



PASSENGER LOCOMOTIVE 4—6—2 TYPE.—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Designed by A. E. MANCHESTER, *Superintendent Motive Power.* *Built by* C., M. & ST. P. RY.

J. F. DEVOY, *Mechanical Engineer.*

SIX-COUPLED PASSENGER LOCOMOTIVES.

4—6—2 TYPE—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

The policy of the Chicago, Milwaukee & St. Paul Railway is to design and build all of its locomotives. Mr. A. E. Manchester, superintendent of motive power, has put into service a new Pacific type engine with a number of features which differ in a marked way from current practice, this design having been worked out under his direction by Mr. J. F. DeVoy, mechanical engineer of the road. The "Pioneer Limited," which this engine is now hauling, frequently consists of 16 cars, which has proved to be too heavy a load for any engine previously put into service on this road. The new trailing truck, the narrow firebox and short flues are special features of this design, the narrow firebox being one of the points to which Mr. Manchester holds as being correct. After being in service for a month, the steaming qualities are said to be entirely satisfactory. While the length of the firebox is 10 ft. 6 ins., the slope of the back head is such as to necessitate throwing the coal less than 10 ft. to the front end of the grate. The firedoor also is high. This design necessitates an extremely long smokebox, the distance from the front tube sheet to the forward edge of the smokebox ring being 7 ft. 3 ins. A maximum length of 16 ft. 6 ins. was fixed for the flues, and the diameter was fixed at 2 ins. In arranging the equalizer system a bar was carried across the engine in front of the ash pan, to which the longitudinal trailing truck equalizers connect. In the trailing truck a lateral movement of 5 ins. is provided, and this without a radius bar or anything which will give a radial movement. This truck consists of a very simple construction of two boxes placed between jaws, the centering effect being obtained by the use of rollers. Not counting the rollers, the truck is in four parts. This construction will be referred to again in detail. The chief feature of interest is the fact that the engine was designed throughout and built by the road, this being the only railroad in the country which has adopted this policy, which was not at all uncommon years ago. If the narrow firebox and long smokebox prove satisfactory in service, current practice will be shown to be wrong. The chief dimensions are presented in the following table, which also includes the tractive effort and adhesive ratio:

PASSENGER LOCOMOTIVES, C. M. & ST. PAUL RY., 4-6-2 TYPE.

Gauge of track	4 ft. 8½ ins.
Cylinders	23 ins. by 26 ins.
Driving wheels, diameter	72 ins.
Weight on driving wheels	142,000 lbs.
Weight of engine, total	218,000 lbs.
Weight of tender loaded	125,600 lbs.
Weight of engine and tender	343,600 lbs.
Wheel base of engine	32 ft. 5 ins.
Driving wheel base	17 ft. 1 in.
Wheel base of engine and tender	60 ft.
Boiler pressure	200 lbs.
Boiler plates, steel, thickness	¾ in.
Firebox plates, thickness	½ in., ⅜ in. and 5-16 in.
Firebox, length and width	41⅛ in. by 126 in.
Firebox, depth	70½ in. and 84 in.
Staying	radial
Flues, number	363
Flues, length	16 ft. 6 ins.
Flues, diameter	2 ins.
Heating surface, flues	3,136 sq. ft.
Heating surface, firebox	245.6 sq. ft.
Heating surface, total	3,381.6 sq. ft.
Grate area	35.8 sq. ft.
Boiler, diameter first ring	72 ins.
Center of boiler above rail	113 ins.
Steam ports	1⅝ ins.
Exhaust ports	2½ ins.
Bridges	1⅞ ins.
Eccentric throw	6 ins.
Valve travel	6 ins.
Steam lap	1 in.
Exhaust lap (negative)	⅛ in.
Driving journals	9 ins. by 12 ins.
Crank pin journals, front	5 ins. by 4½ ins.
Crank pin journals, main	6½ ins. by 7 ins. and 7½ ins. by 4¾ ins.
Engine truck wheels	33 ins.
Trailing wheels	42 ins.
Tender coal capacity	10 tons
Tender water capacity	7,000 gallons
Tractive effort	32,500 lbs.
Ratio of adhesion	4.36

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL

CANADIAN PACIFIC RAILWAY.

IV.

(For previous article, see page 37.)

POWER PLANT.—The power plant is in a 100 by 160 ft. building, divided into a boiler and an engine room by a longitudinal wall. The boiler room has seven Babcock & Wilcox boilers of 416 h.p. each, at 150 lbs. pressure and one 300 h.p. of the same make, with a pressure of 300 lbs., intended for use in testing locomotives and provided with reducing valves for use with the other boilers. Four boilers have Neemes' shaking grates arranged for hand firing and also to receive shavings from an extensive shavings exhaust system from the planing mill and cabinet shop. Three boilers have Babcock & Wilcox chain grate stokers. Induced draft is furnished by two 10-ft. Sturtevant fans, used in connection with an 8-ft. steel stack 70 ft. high. The fans run at about 200 r.p.m., and work in connection with two Green economizers, which are connected to all of the eight boilers. The boilers connect to a 12-in. boiler room header. Feed water is supplied by two 12 by 7 by 12 in. Northey feed pumps and two 6 by 3½ by 6 in. feed pumps are provided specially for the high pressure boiler. Coal is discharged in front of the boilers from a trestle outside of the building. Ashes pass into the hoppers at the floor, from which they are emptied into cars on a track in the tunnel under the boiler room floor, reaching an air hoist outside of the building for dumping the cars into freight cars on a service track. Tunnels run from the power house to the most important buildings, carrying the steam pipes, water pipes and drainage returns from the various buildings.

Along the boiler room wall, the full length of the engine room, is a large pit, which provides for all of the pumps and piping connected therewith, and this is depressed about 6 ft. 6 in. below the main engine room floor. It is spanned by gratings for passage ways over it. The main engines, three in number, are of 750 h.p.; in addition to these there is one 375 h.p. auxiliary. All of them run at 150 rev. per min. In the drawings and photographs of the power house the arrangement of piping is shown. This power plant was designed by Mr. Henry Godmark, Messrs. Ross & Holgate, acting as consulting engineers.

GENERATORS AND ENGINES.—Canadian General Electric Company's apparatus is installed throughout. Both alternating and direct current systems are used, the latter only for the cranes and a few individual tool drives. The alternating current is 3-phase, 60-cycle and 600-550 volts, the direct current being at 275-250 volts. Generating apparatus is installed as follows:

Three alternators of 500 k.w. nominal rating; voltage, full load 600; amperes, 480; rev. per min., 150 direct connected to Robb-Armstrong cross-compound non-condensing engines having 21 and 33 by 24 in. cylinders. One alternator of 250 k.w. nominal rating; voltage, full load 600; amperes, 240; rev. per min., 150, direct connected to a Robb-Armstrong non-condensing engine having 18 by 24 in. cylinders. Two D. C. generators giving 250 volts at no load and 275 volts at full load, amperes, 727; running at 180 rev. per min., each direct connected to a Robb-Armstrong non-condensing 18 by 20 in. engine. Two exciter sets giving 115 volts at no load and 125 at full load, amperes, 400; running at 230 rev. per min., each direct connected to a Robb-Armstrong 10 by 12 in. non-condensing engine.

SWITCHBOARD.—The board has 4 A. C. generator, 1 A. C. totaling, 10 A. C. feeder, one exciter and two D. C. generator panels. It has one panel for series-arc lamps and one spare panel for an additional A. C. generator. The generator and feeder circuits are all fully equipped with Thompson ammeters and wattmeters. The A. C. totaling and the generator panels have power factor indicators and a synchronizing indicator. All the A. C. panels have double throw oil switch circuit breakers with time relays, connecting to either the main or auxiliary sets of bus bars. Series-arc lamps are used only for yard lighting, the shop lamps being fed from the power circuits.

MOTORS.—The A. C. motors aggregating 4,495 rated h.p. are of the constant speed induction type, with the exception of three motors, aggregating 70 h.p. which have secondary resistance external to the motors. All are wound for 550 volts. They range in size from 3 to 100 h.p. The direct current motors, aggregating 821 h.p., working on a voltage of 250, are used on the cranes, with the exception of 100 h.p. for individual tool drives in the locomotive shop. These have a 2 to 1 speed variation by means of variable field resistance. The distribution of the motors is shown in the motor table. Induction motors are used almost exclusively for driving groups and individual machines, with the exception of the cranes. The high efficiency of these motors, their durability and relatively low cost from repairs, led to their selection in preference to other types for the requirements of nearly constant speed and fairly uniform load. They are not readily adaptable to variable speed as required for individual machine drives, and when they are given variable speed characteristics the speed depends too largely upon the load. Woodworking machinery and group driving of machine tools and individual driving of tools requiring constant speed and fairly constant load, constitute the A. C. motor field.

MOTOR DISTRIBUTION.

ALTERNATING CURRENT INDUCTION MOTORS.

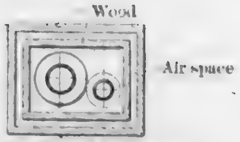
	Rated Horsepower of Motors.			
Shop.	Individual Drives.	Group Drives.	Fans and Blowers.	Total.
Planing mill	800	500	340	1,640
Cabinet	90	139	50	279
Power house	—	—	80	80
Truck	10	125	—	135
Car, machine and freight	55	190	—	245
Blacksmith	297	—	405	702
Grey iron foundry	3	23	50	76
Upholstery	—	10	—	10
Passenger car	—	10	—	10
Frog and switch	148	40	42	230
Boiler	118	27	40	185
Locomotive machine	220	574	—	794
Pattern	—	20	—	20
Wheel foundry	—	—	65	65
Transfer table	20	—	—	20
Totals	1,761 H.P.	1,658 H.P.	1,072 H.P.	4,491 H.P.
Percentage of total	39.2	37.0	23.8	100

DIRECT CURRENT MOTORS.

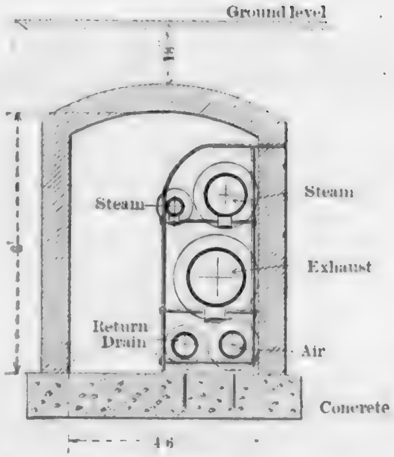
Shop.	Individual Drives.	Cranes.	Totals.
Midway crane	—	110	110
Wheel foundry	—	33	33
Locomotive machine	100	—	100
Locomotive shop	—	503	503
Grey iron foundry	—	65	65
Frog shop	—	10	10
Totals	100 H.P.	721 H.P.	821 H.P.

SHAVINGS EXHAUST.—This plant has the most extensive system of collecting and conveying shavings ever put into railroad shops. At the power house is a storago vault sufficient for a day's product from the mill and cabinet shop. Shavings are delivered direct from these buildings to the boilers or they may be sent down into the vault for storage. When working at its full capacity, building 30 cars per day, shavings enough will be produced to take the place of 18 tons of coal in the power house. Shavings are raised from the vault and delivered to the boilers by means of the blowers on top of the vault and through conduit connections, not shown in the engravings. This system will be referred to again in connection with the planing mill. At this plant the use of shavings was sufficiently important to influence the location of the power house. This is Sturtevant apparatus installed by C. H. Gifford & Company, managers of the Philadelphia house.

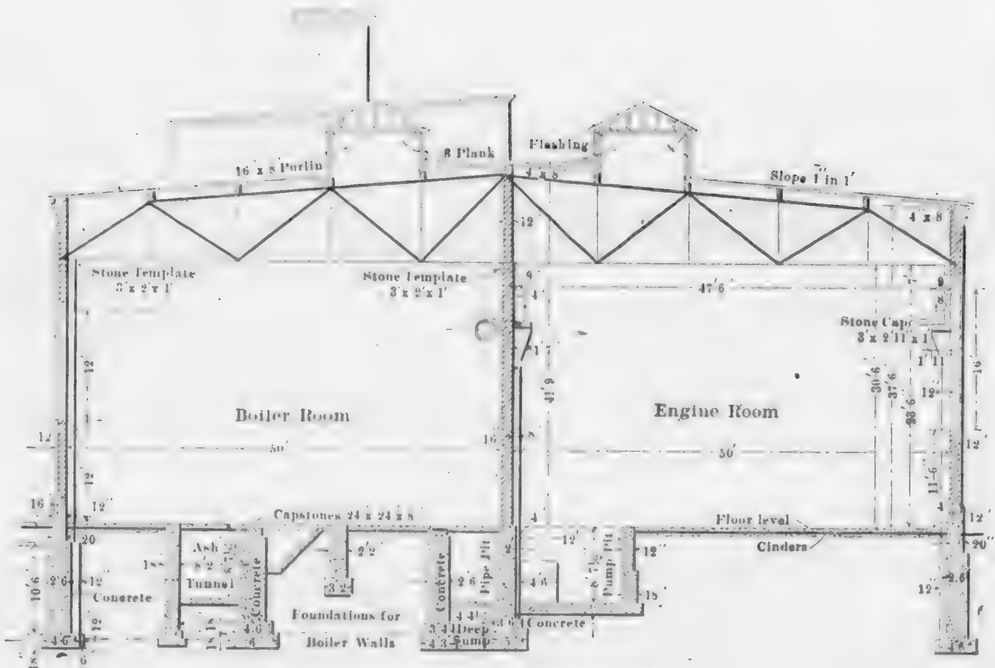
AIR COMPRESSOR.—Two machines by the Allis-Chalmers-Bullock Company have 20 by 24 in. high pressure steam, 32 by 24 in. low-pressure steam and 18¼ by 24 and 30¼ by 24 in. air cylinders. The valves are of the Meyer cut-off type, speed 65 to 100 rev. per min., with intercooler between the air cylinders. These have a capacity of 2,000 cu. ft. of free air per minute each.



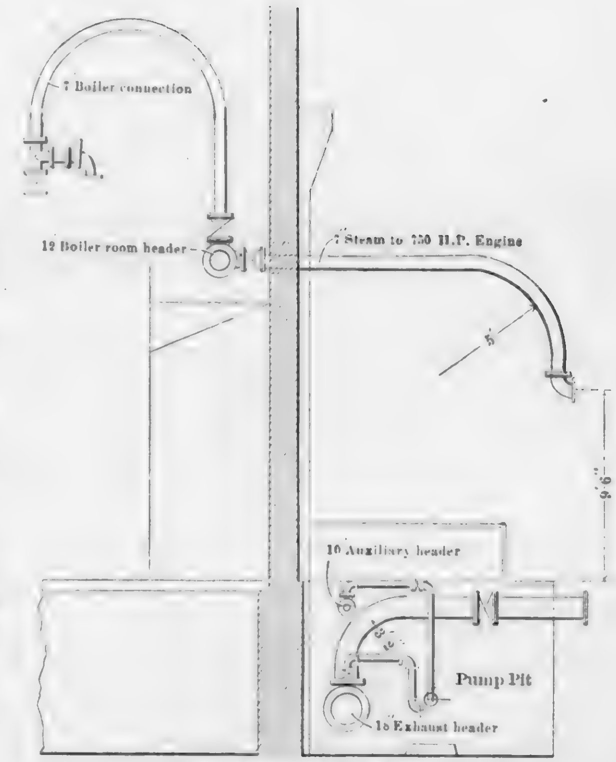
Section of Casing for Overhead and Underground Piping



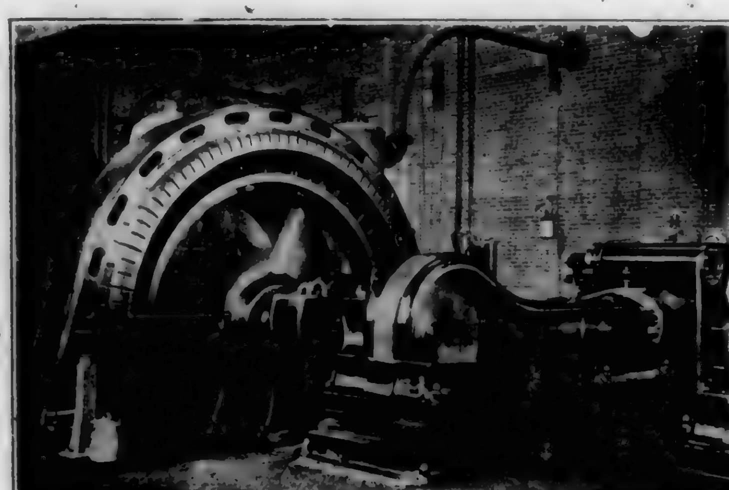
PIPE TUNNEL.



SECTION THROUGH POWER HOUSE.



ARRANGEMENT OF PIPING.


ONE OF THE LARGE UNITS.


DUST COLLECTOR AND STORAGE.

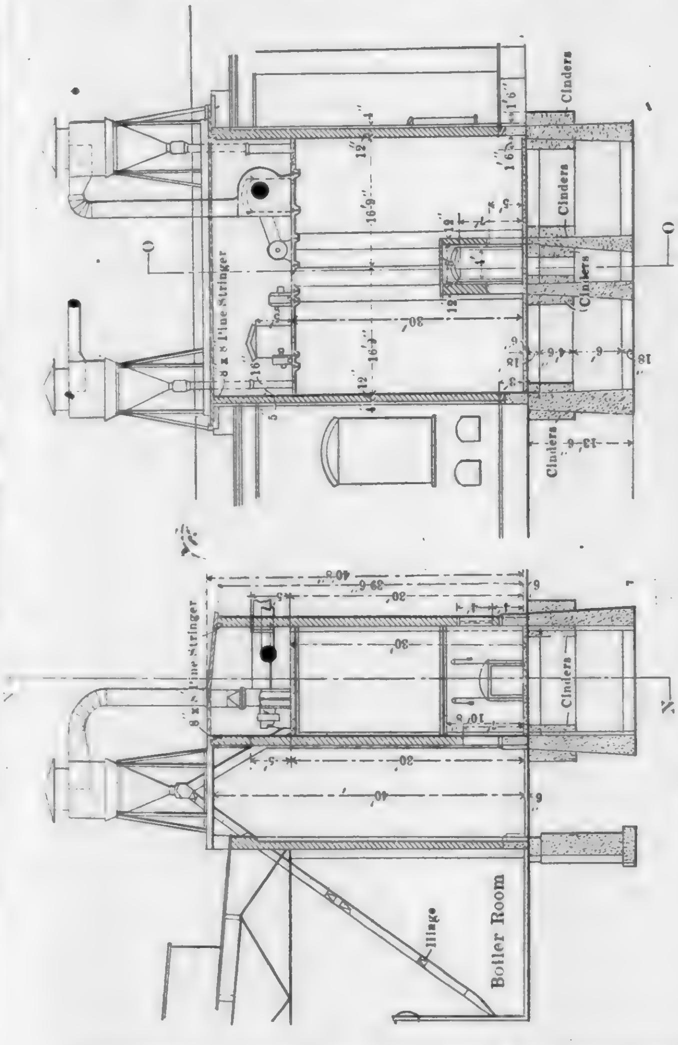

POWER HOUSE INTERIOR.
PUMP PIT AT THE LEFT.


DELIVERY OF SHAVINGS TO BOILERS.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.—CANADIAN PACIFIC RAILWAY.

DATA CONCERNING LARGE CRANES.—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

Location in Shops.	Number of Cranes.	Capacity, Main.	Capacity, Auxiliary.	Span.	Lift of Hook.	Height of Crane.	Motors—H.P. Drum Hoist.	Trolleys.	Bridge.	Auxiliary Hoist.	Speeds in feet, per min. Main Hoist, Loaded.	Trolleys, Loaded	Bridge, Loaded	Aux. Hoists, Loaded	Crane Clearance at Center.
Erecting shop	2	60	10	76 ft. 5 ins.	25 ft. 8 ins.	10 ft. 6½ ins.	50	7½	50	27	10	100	250	25	24 ft. 10 ins.
Machine shop	1	15	—	51 ft. 11 ins.	25 ft. 8 ins.	6 ft. 6¼ ins.	27	3½	27	—	19	125	300	—	25 ft. 6 ins.
Machine shop	1	10	—	51 ft. 11 ins.	25 ft. 8 ins.	6 ft. 2 ins.	27	3	27	—	27	150	300	—	25 ft. 6 ins.
Boiler shop.......	1	20	5	76 ft. 5 ins.	25 ft. 8 ins.	——	25	5	25	10	12	100	250	20	25 ft. 6 ins.
Midway	1	10	—	77 ft. 0 ins.	30 ft. 0 ins.	——	25	3	25	—	25	125	250	—	——
Foundry (outside).	1	10	—	60 ft. 0 ins.	30 ft. 0 ins.	——	25	2	25	—	25	125	350	—	——
Foundry (inside)..	1	10	—	60 ft. 0 ins.	22 ft. 0 ins.	——	25	2	25	—	25	125	350	—	——



SECTION AT N N.

SECTION AT O O.

SECTIONS THROUGH SHAVINGS STORAGE VAULT.

DISTRIBUTION.—From the switch board the feeder lines pass into a 10 by 12 ft. brick tower built into the power house wall. From there the distribution is by bare copper on poles built up of four 15.6 lb. Z bars with a ⅜-in. web plate. These are 62 ft. high, including the portion under ground 8 ft. and they provide for 7 cross-arms. Fourteen of these poles take the feeders past the blacksmith shop between the car machine and the truck shops to the locomotive shop, with branch connections to all the other buildings. The cables are 250,000 c. m. bare copper, in 100 ft. spans with a sag of 2½ ft. in summer. All cables are "dead ended" at the entrance to all buildings. The wiring in the buildings is partially of open cleat work with slow burning weather proof wire and partially conduit work with rubber covered wire. For every 100 h. p. of motor circuits an oil circuit breaker and no-voltage release is provided. The lighting scheme includes 400 Canadian General Electric, 110-volt, incandescent arc lamps and nearly 4,000 110-volt 16 candle power incandescent lamps. The yards are lighted by 50 6.6 amperes, series, alternating, enclosed arc lamps.

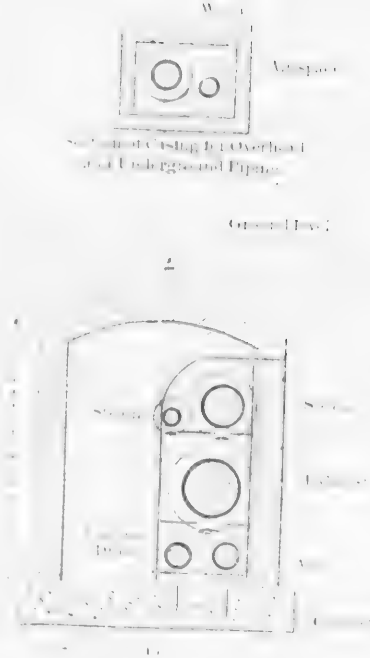
Power for the inside lighting is taken from the A. C. generator cables, the voltage being transformed down to 110. The transformers are hung on the outside walls of the wood working shops and the columns of the other buildings. Only one size 10 k.w. is used. These are General Electric Type H., oil cooled. The secondaries are carried to cabinet panels in conduits or on cleats according to the construction of the building. The buildings are lighted with a mixed system of 16 c.p. 110-volt incandescent lamps and multiple arc lamps of 110 volts and 6.6 amperes. Drop lights are placed over each machine. Wires are carried through floor conduits to the benches. In the passenger car shops plugs are provided at all pillars. The arc lamps are hung about 20 ft. above the floor and usually along both sides of the shops, about 50 ft. apart. The lighting of the locomotive shop will be referred to again.

ELECTRICAL CONDITIONS.—Because of the extent of this plant and the combination of car and locomotive work in one shop group the transmission problem was both important and difficult. The advantages of alternating and direct current which were considered in connection with this shop problem are summed up as follows:

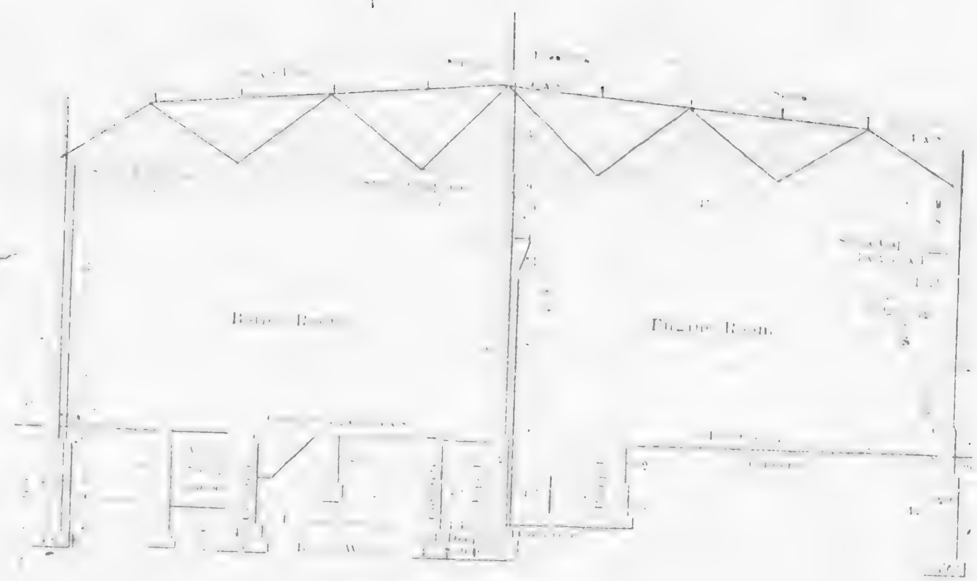
ADVANTAGES OF A. C.—1. No commutators or brushes on the motors—in the grit and the fumes of the foundry this is important. 2. Safety.—In the wood shop, with its fine and almost explosive dust the fire hazard is greatly reduced with motors of the A. C. type. If D. C. motors are used they must be completely enclosed, which is expensive (in this case the lack of ventilation is a source of danger). 3. Transmission over long distances.—The A. C. has an advantage in greater flexibility for extension over long distances. In case of necessity of pumping water or extending the lighting system to a long distance, the A. C. is and the D. C. is not suitable. 4. Independent supply.—If A. C. is used, power may be purchased from commercial electric companies, which is usually not practicable with D. C. current. 5. Repairs.—A. C. motors will run with less repairs and attendance. 6. Tendency.—A. C. current is rapidly displacing D. C.

ADVANTAGES OF D. C.—1. For this plant it would have been cheaper in first cost by about $11,000. 2. No motor generators for variable speed tools and cranes, or transformers for lighting would be required in the shops. 3. Slower speed motors could be used with direct current. This would help in belting in some cases to slow running shafts, especially in the machine shop, and it would be advantageous in other shops. 4. But one universal system of wiring would be necessary. 5. All apparatus except motors is confined to the power house, where it may be easily cared for. 6. Simpler wiring, as all current would be distributed from the power station at 250 volts direct to all motors and lamps. 7. Better commercial competition for motor and generator contracts.

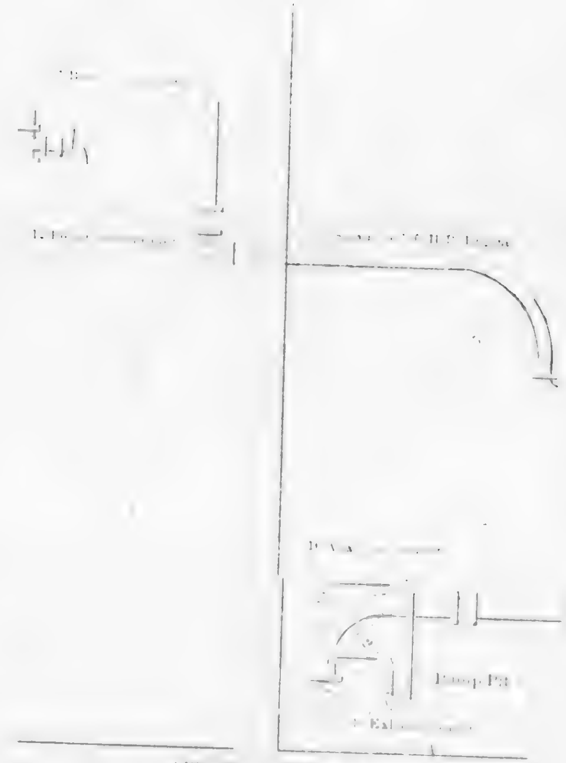
Mr. Dietrich is of the opinion that D. C. variable speed motors should be used for all variable speed machines. (EDITOR'S NOTE.—There is not enough variable speed power in the locomotive shop to obtain the full value of electric driving.) Of the six methods of varying the speed of polyphase motors the following are mentioned as possible: (1) Varying the number of poles; (2) varying the alternations applied; (3) Motors in tandem or series—parallel; (4) secondary run as single phase; (5) varying the resistance of the secondary; (6) vary-



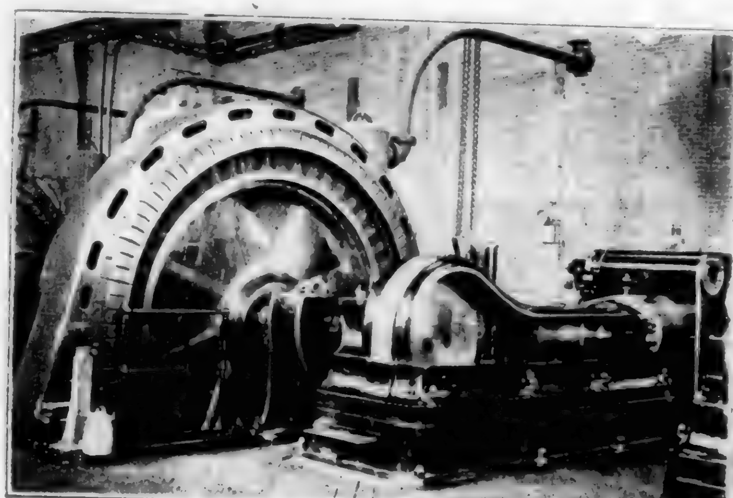
PIPE TUNNEL.



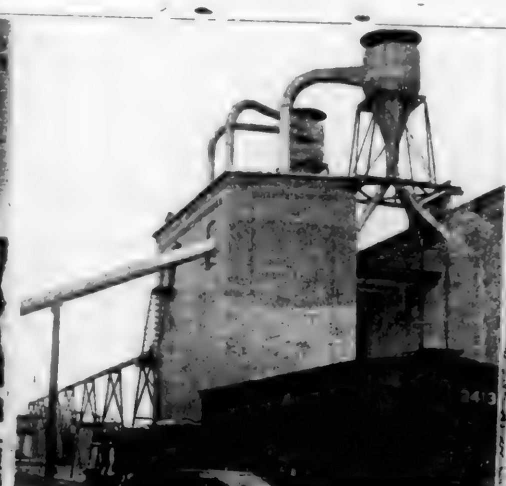
SECTION THROUGH POWER HOUSE.



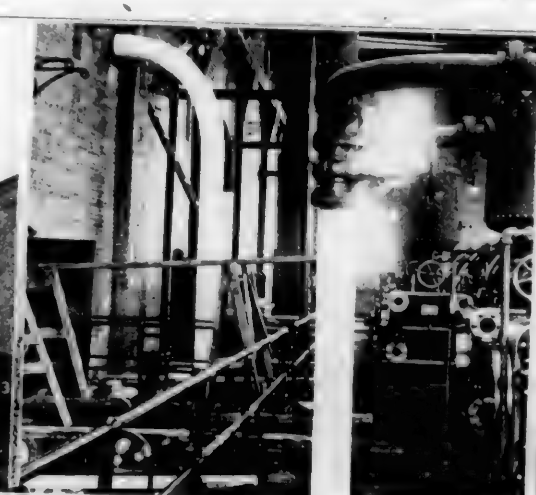
ARRANGEMENT OF PIPING.



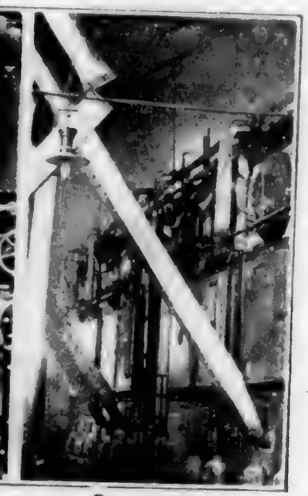
ONE OF THE LARGE UNITS.



DUST COLLECTOR AND STORAGE.



POWER HOUSE INTERIOR.
PUMP PIT AT THE LEFT

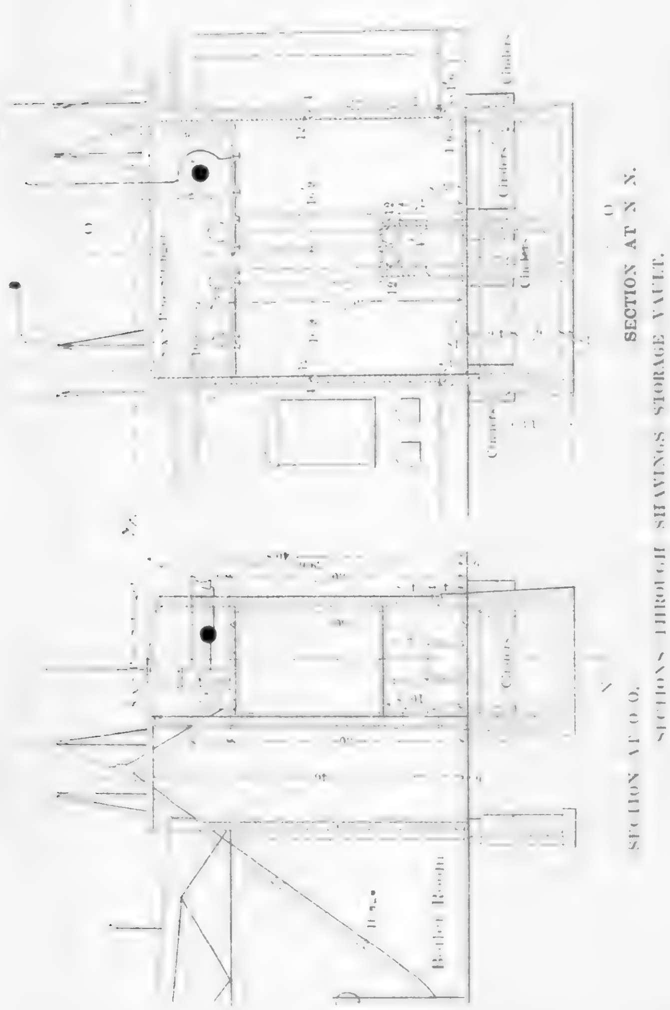


DELIVERY OF SHAVINGS
TO BOILERS.

ANGUS LOCOMOTIVE AND CAR SHOPS. MONTREAL. CANADIAN PACIFIC RAILWAY.

DATA CONCERNING LARGE CRANES.—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY

Location in Shops.	Number of Cranes.	Capacity, Main.	Capacity, Auxiliary.	Span.	Lift of Hook.	Height of Crane.	Motors—H.P. Main Hoist.	Trolleys.	Bridge.	Auxiliary Hoist.	Speeds in feet, per min. Main Hoist Loaded.	Trolleys Loaded.	Bridge Loaded.	Aux. Hoist Loaded.	Crane Clearance at Center.
[illegible] Shop	2	60	10	76 ft. 5 ins.	25 ft. 8 ins.	10 ft. 6½ ins.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]chine shop	1	15	—	51 ft. 11 ins.	25 ft. 8 ins.	6 ft. 6½ ins.	[illegible]	[illegible]	[illegible]	[illegible]	19	[illegible]	[illegible]	[illegible]	25 ft. [illegible]
Machine shop	1	10	—	51 ft. 11 ins.	25 ft. 8 ins.	6 ft. 2 ins.	27	[illegible]	[illegible]	[illegible]	27	15	[illegible]	[illegible]	25 ft. [illegible]
[illegible] shop	1	20	5	76 ft. 5 ins.	25 ft. 8 ins.	——	25	5	[illegible]	10	12	[illegible]	250	[illegible]	25 ft. 6 ins.
Midway	1	10	—	77 ft. 0 ins.	30 ft. 0 ins.	——	[illegible]	[illegible]	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	——
Foundry (outside)	1	10	—	60 ft. 0 ins.	30 ft. 0 ins.	——	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	125	[illegible]	[illegible]	——
Foundry (inside)	1	10	—	60 ft. 0 ins.	22 ft. 0 ins.	——	25	2	25	[illegible]	[illegible]	125	[illegible]	[illegible]	——



SECTION AT N. N.

SECTIONS THROUGH SHAVINGS STORAGE VAULT.

SECTION AT O. O.

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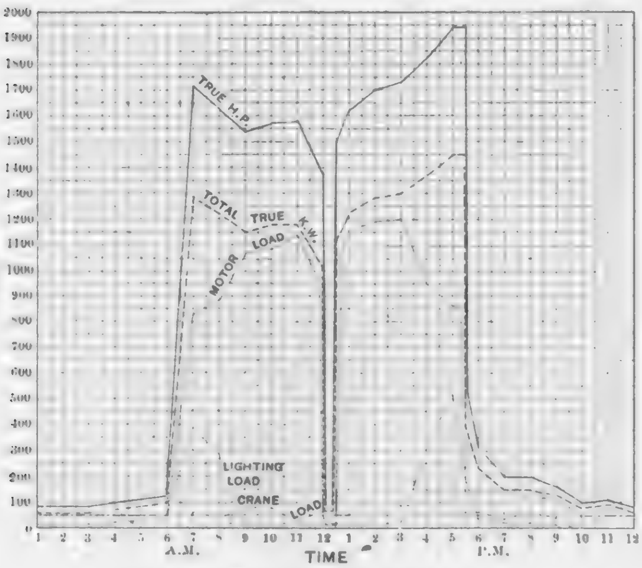
ing the electro-motive force of the primary, with constant secondary resistance—but one (5) is used here and it is not entirely satisfactory, but the others could not be used to advantage.

Load Factors.—In general the generator capacity should be slighty in excess of one-half of the total rated motor capacity. The load factors from each department, as taken from actual readings are: Planing mill, 61 per cent.; blacksmith shop, 31 per cent.; locomotive shop, 34 per cent.; cabinet shop, 37 per cent.; frog shop, 26 per cent.; foundries, 70 per cent. One of the engravings presents the output curve for the generators for December 22, 1904. The maximum load, at 5 p. m., was



CURVE SHOWING POWER DISTRIBUTION.

1,940 h.p., the average from 7 a. m. to 5.30 p. m. was 1,560 h.p. The load factor was 80 per cent. and the power factor of the maximum load 68. For the entire 24 hours the average load was 850 h.p. and the load factor 44 per cent. This was a stormy day, requiring a large lighting load.

A summary of information concerning the larger cranes of this plant is given in the accompanying table.

Valuable assistance in connection with this article was rendered by Mr. H. H. Vaughan, superintendent of motive power; Mr. W. N. Dietrich, electrical engineer, and Mr. G. B. Mitchell, resident engineer.

Welding Frames Under Engines.—This work has become a very important factor in many repair shops, and as the idea originated with us at the Renovo shop on the P. & E. R. R., we will no doubt be pardoned for taking such interest in the question. We made our first weld in August, 1899, and have successfully carried on the method up to date. We have repaired 50 or more frames successfully, and always do it by this method when it is possible to get our furnaces around the broken parts.—J. W. Russell, *before National Railroad Master Blacksmiths.*

Banked Fires for Fire Protection.—A well banked ordinary factory boiler may be relied on to promptly operate a fire pump at the rate of 1,000 gals. per minute. Banking such a boiler so as to maintain 50 lbs. steam pressure need not require more than 800 lbs. of coal per day. In a test made at a New England mill four fire streams were had in 13 minutes when the boiler had been banked for a week. Four tests on boilers in different mills showed that an average time of 1 hour 30 minutes was required to get up 50 lbs. of steam on cold boilers. These tests were conducted by the Associated Factory Mutual Fire Insurance Companies in order to determine the importance of keeping up steam for fire purposes. *Engineering News*, Nov. 3, 1904, page 401 contains a complete account of the tests.

PRAIRIE TYPE FREIGHT & PASSENGER LOCOMOTIVE.

Chicago, Burlington & Quincy Railway.

This road has received 50 passenger and freight locomotives from the Brooks Works of the American Locomotive Company of the 2—6—2 type, which are a logical development of the previous designs of this type illustrated in April and July, 1900, pages 103 and 217; May, 1901, page 135, and November, 1902, page 343, the present design being the fourth of this type on this road. The first of this class was the pioneer of the present development of wide fireboxes for bituminous coal. All of these engines have had outside journals for the trailing wheels and the splices with spreading of the back ends of the frames, illustrated in April, 1900, page 105. The tractive effort of each of these designs is as follows: Class R, 21,860 lbs.; Class R2, 25,500; Class R3, 28,300 lbs., and Class R4, 35,050 lbs.; thus indicating a remarkable advance of from 21,860 to 35,060 lbs., or almost exactly 60 per cent. in four years in a continuous series of locomotives designed in accordance with a systematic plan by the railroad officials. In these days of hitting and missing, it is a pleasure to record facts which reflect a definite plan in locomotive progression. It indicates that the officials understand their conditions and that they know what they want. These locomotives were built throughout from the railroad company's drawings.

All of these engines have piston valves. In the present design they are 12 ins. in diameter, placed between the bars of the frames and almost exactly central therewith. With this low location and inside admission valves with direct motion the rocker boxes are supported on the lower bars of the frames and but a single rocker arm is required. This is a novel and interesting arrangement, giving a reduced cylinder clearance, light cylinder castings and open eccentric rods.

The Burlington trailer truck is used on all Class R engines with boxes in pedestals, with roller bearings over them. The trailer eqqualizers connect with a transverse equalizer in front of the wheels.

The boiler is straight and has 301 2¼-in. tubes, 19 ft. long. The tube sheets are arranged so that superheaters may be applied, in fact a trial of the Cole superheater is to be made in one of these engines. These tenders are very large, providing for 16 tons of coal and 8,000 gals. of water. Sheet steel shields, open at the top, prevent coal from falling off. For coal gates, planks in sockets are used, with spaces between them. All of the Burlington locomotives have gates across the gangways. Several of these engines are to burn lignite, and this feature and the tenders will be referred to again. These engines are used in fast freight and heavy, moderate speed passenger service.

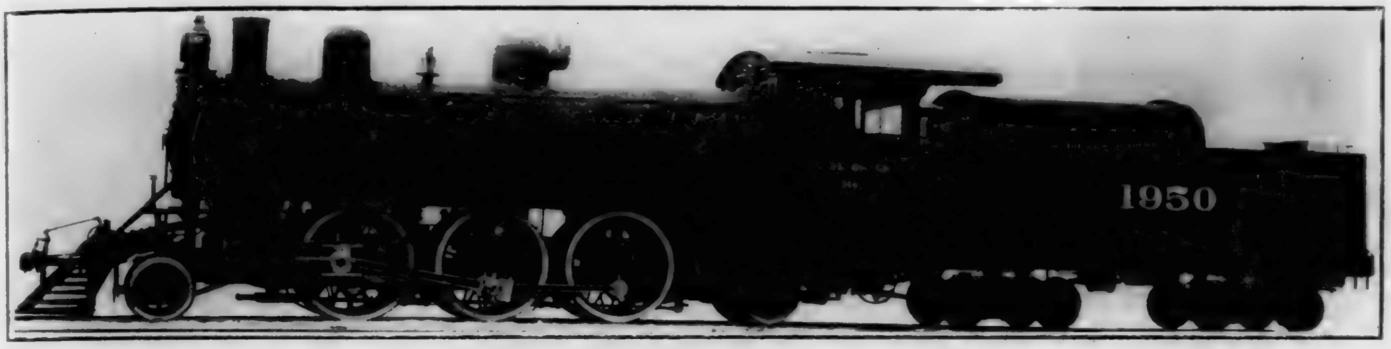
That the Burlington is using the Prairie type so successfully supports the two-wheel leading truck in a forcible way, as it is by no means free from sharp curves. The leading dimensions of this locomotive are as follows:

GENERAL DIMENSIONS.	
Gauge	4 ft. 8½ ins.
Fuel	6 engs. bituminous coal; 6 engs. lignite
Weight in working order	212,500 lbs.
Weight on drivers	154,000 lbs.
Wheel base, driving	13 ft. 4½ ins.
Wheel base, total	30 ft. 8½ ins.
Wheel base, total engine and tender	62 ft. 2¾ ins.
Tractive power	35,053 lbs.
CYLINDERS.	
Diameter	22 ins.
Stroke of piston	28 ins.
Diameter of piston rod	4 ins.
Kind of piston packing	Dunbar
VALVES.	
Kind	piston
Travel	5¾ ins.
Steam lap	1⅛ ins.
Exhaust lap	⅛ in.
WHEELS.	
Diameter of driving wheels outside of tire	69 ins.
Diameter of driving wheel centers	62 ins.
Material of driving wheel centers	cast steel
Diameter of engine truck wheels	37½ ins.
Diameter trailing truck wheels	42½ ins.
Diameter and length of driving journals	9½ ins. by 12 ins.
Diameter and length of trailing truck journals	8 ins. by 12 ins.
Engine truck, kind	2-wheeled radial
Engine truck journals	6 ins. by 10 ins.
BOILER.	
Style	radial stay, straight top
Outside diameter of first ring	70 ins.
Working pressure	210 lbs.

Firebox, length	109 ins.
Firebox, width	73 ins.
Firebox plates, thickness	sides, ⅜ ins.; back, ⅜ ins.; crown, ⅜ ins.; tube sheet, ½ in.
Firebox, water space	front, 4½ ins.; sides and back, 4 ins.
Tubes, number	301
Tubes, diameter	2¼ ins.
Tubes, length	19 ft.
Tubes, gauge	No. 11
Heating surface, tubes	3,343 sq. ft.
Heating surface, firebox	170.9 sq. ft.
Heating surface, total	3,513.9 sq. ft.
Grate, area	54 sq. ft.
Gate, style	Rocking
Exhaust pipe	single
Smoke stack, top above rail	15 ft.

TENDER.

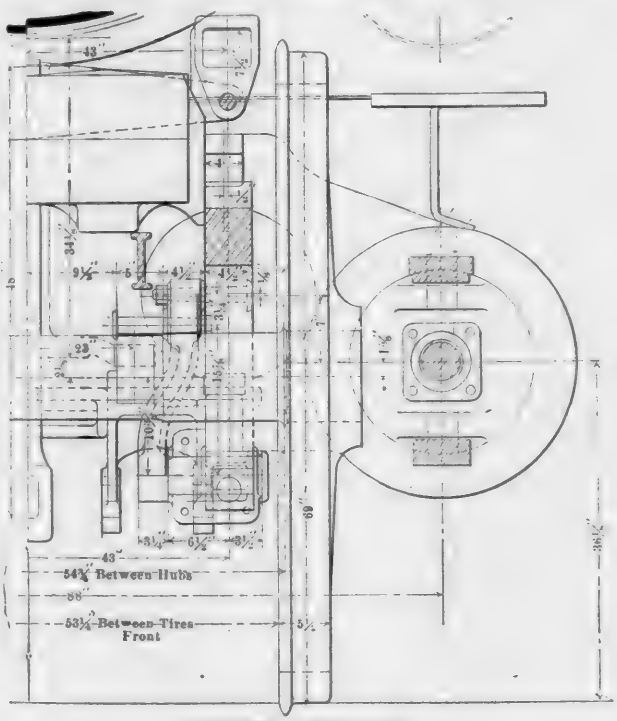
Style	water bottom
Wheels, diameter	33 ins.
Journals, diameter and length	5½ x 10 ins.
Tender frame	12 in. channel
Water capacity	8,000 gals.
Coal capacity	16 tons.



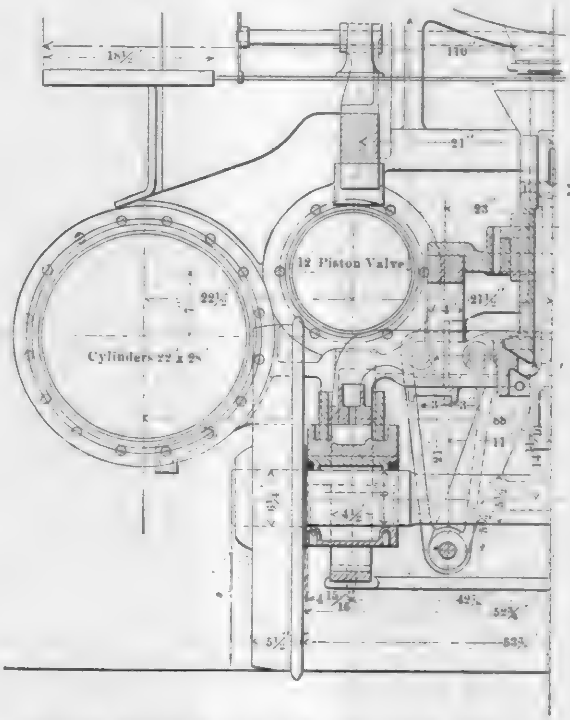
PRAIRIE TYPE PASSENGER AND FREIGHT LOCOMOTIVE.—C., B. & Q. RY.

Designed by F. H. CLARK, *Superintendent of Motive Power.* C. B. YOUNG, *Mechanical Engineer.*

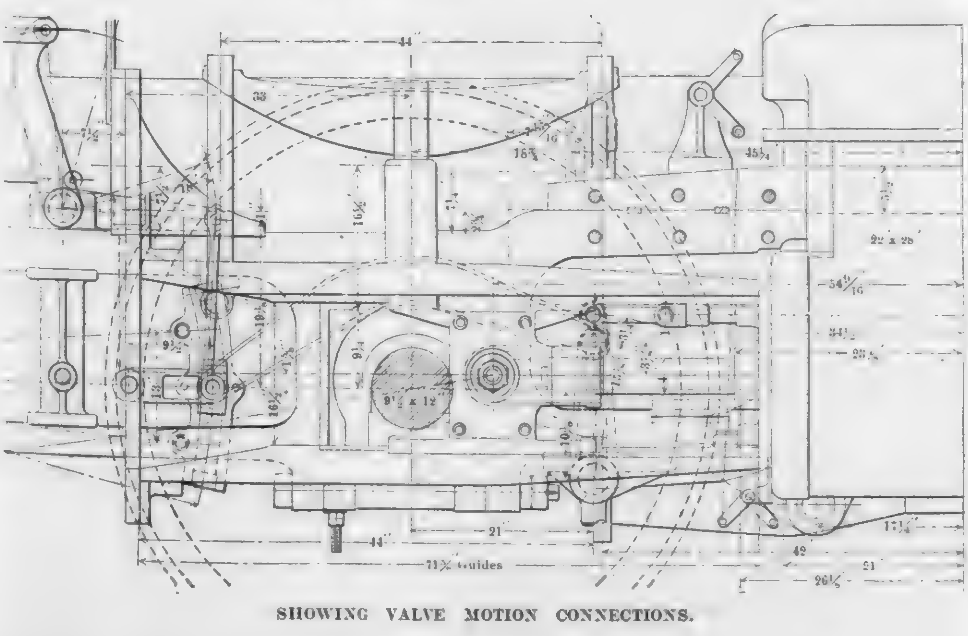
AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders.*



SHOWING ROCKER ARM.



SECTION THROUGH CYLINDER AND VALVE CHEST.



SHOWING VALVE MOTION CONNECTIONS.

THAWING WATER PIPES ELECTRICALLY.—The Public Service Corporation of New Jersey derived a gross revenue of $12,000 in a year by using electric current to thaw out water pipes. A special portable transformer for this purpose is made by the General Electric Company. Current is connected to the pipe to be thawed, and the pipe itself is heated by a heavy current, whether it is above or below ground. Care is required to make good contacts with the pipe or faucets, in order to guard against burning them. A scheme of this kind should be very useful about railroad shops and roundhouses, where electric current is usually available, in view of the fact that freezing of pipes is a very serious matter in Northern climates.

NEW ROUNDHOUSES AT ELKHART.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

(*For previous article see page* 42.)

It is significant of the progress in roundhouse construction and equipment that the houses at Clinton, Iowa, Chicago & Northwestern (AMERICAN ENGINEER, January, 1901, page 25) at Collinwood, Ohio, Lake Shore & Michigan Southern (October, 1901, page 305) and at Rensselaer, N. Y. (February, 1902, page 49) are already obsolete and offered little of interest in drawing up the plans of the new houses at Elkhart.

The present problem is to provide a house which may be heated and ventilated and then to equip it with the best possible facilities for rapid work. The roundhouse has really become a shop for running repairs and the housing function is secondary. Because of their importance special attention is given, in this description, to the boiler washing and water changing system.

WASHOUT SYSTEM.—This interesting system includes two sets of heaters in an annex to the power house combined with piping extending through the pipe tunnel entirely around both roundhouses. The tunnel piping consists of an 8-in. blow-off and 4-in. hot and cold water pipes. Connections are brought from the main pipe tunnel to each post in both roundhouses, consisting of a 2-in. cold water pipe, a 2-in. hot water pipe, a 4-in. blow-off and a 1-in. air pipe. At each post is an assembling connection, or monitor, which is shown in Fig. 7 and again in Fig. 9. At each of the posts connections are provided for blowing-off from the water leg and from the dome, and both hot and cold water are available for washing out and filling up. The operation of the system is illustrated by an ideal diagram, Fig. 12, simplified to show the principles. Seven separate conditions are illustrated. The locomotive at the left is connected for blowing down the water only. This passes through the 8-in. pipe to the lower or preliminary heater, the overflow passes to the sewer, and vapor from the surface passes away through the upper or steam heater. The pump shown in this engraving is connected to the cold water suction. It will pump cold water to each post in the roundhouse, or it will pump cold water into the coil in the lower heater from which it passes to the coil in the steam heater and thence into the hot water main to all the posts for washing out or filling boilers. By this arrangement the heat from the blow-off water, or from steam blown from the domes of the locomotives, is utilized to heat water for washing and filling. Live steam may be applied to the upper or closed heater in case it is required.

The second locomotive in Fig. 12 is connected for blowing down the water on both sides of the fire box and blowing off steam from the dome. The third is connected for blowing off steam from the dome only. The fourth for washing out. The fifth for changing water under pressure, in which case the dome connection brings hot water into the boiler. The sixth is connected for refilling with hot water, and the seventh for washing out with hot water.

This system can furnish water at a temperature of 350 deg. by applying live steam to the upper heater, but usually waste heat from blowing off will be entirely sufficient without using live steam. When changing the water it is done without drawing fires. It is not the intention to knock down the fires when the water is to be changed, the water being blown off at about 100 lbs. pressure and the amount blown out from the bottom of the boiler replaced at the top with water heated to 350 deg. About half an hour would be required for this water changing, and this installation is expected to greatly reduce the number of times of washing out; it will also relieve the boiler from destructive stresses from cooling down and will save about 75 per cent. of the fuel required to get up steam again. Both heaters combined have a capacity of 5,200 gallons of water. The water and steam blown off from an ordinary locomotive will raise 5,200 gallons, the combined capacity of both heaters, from 50 to 210 deg. Washing out is done with water at a temperature of from 110 to 135 deg. About 3,000 gallons are required to thoroughly wash a boiler, 1,500 gallons of hot water from the heaters mixed at the turret with say 1,500 gallons of cold water. About 2,500 gallons are required to fill the larger locomotive to 2 gages. In ordinary service probably about 2,000 gallons will be used in washing out. In view of the fact that 1½ hours must be allowed to getting steam up to 110 lbs. from cold water the importance of the improvements described on page 42 of the February number is readily realized.

Connections for the steam domes to the monitors are made through 3-in. pipes extending up the posts, branching into 3-in. pipes in each direction, reduced to 2½-in. pipes for the second pit at each side of the monitor. Down connections of 2-in. pipe reach the domes by means of flexible joints. These are attached to the dome blow-off nipples by means of couplings having interrupted threads for rapid attachment.

In order to keep the hot water circulating in the roundhouse piping a 1-in. circulating pipe runs from the ends of the hot water mains in the roundhouse to the power house, consisting of four pipes in all, each fitted with and controlled by a thermostatic valve, which closes automatically when the water at the terminals of the hot water mains reaches 200 deg. These open automatically when the temperature falls below this point. These valves are in the power house and thermometer cups permit the attendants to keep watch of the temperatures. The circulating pipes discharge into the pump suction, thus keeping the hot water pipes at a temperature of 200 deg. or above.

Provisions are made for taking care of the sludge from the hot wells and also to flush out the roundhouse blow-off pipe with water under pressure.

STEAM BLOWER PIPING.—A 3-in. steam main is carried around the houses and connected to a 4-in. main in the pipe conduit. From the overhead main 1-in. pipe connections are brought down to about 6 ft. from the floor and are fitted at the top and bottom with flexible joints for conveying the steam to blower pipes on the locomotives. In this way steam may be attached to any blower in either of the houses. The valves are at the 3-in. main and are controlled from the floor by means of ½-in. round rods with universal joints. This 3-in. main is located 35 ft. from the outer wall of the building and is attached to the roof trusses.

AIR PIPE SYSTEM.—Three-quarter-in. air pipes are brought to each of the drop pits. The main air pipes are brought through the pipe conduits to the roundhouse. A 2-in. air pipe extends around each house and is led to the monitors, terminating in connections fitted with Westinghouse cut-out cocks.

AIR SIGNAL TEST.—The passenger house is piped along the inner walls so that each passenger engine air signal may be tested with a loop of piping equivalent to that of a 16-car train. This pipe is looped down at the inside wall of the house on alternate posts to within 6 ft. of the floor, so that a hose connection may be made to the tender coupling. This signal testing line is charged from the main air pipe. At each engine it is equipped with a Westinghouse conductor's valve and with a gage, the piping being so arranged that each engine can be cut into the air signal loop at any pit by means of the valves shown in Fig. 6. These facilities render it possible to test the locomotive signal at the house, so that repairs can be made if necessary before the engine couples to the train. Uncertainty as to the condition of an engine equipment is thus eliminated when the test is made after coupling to the train.

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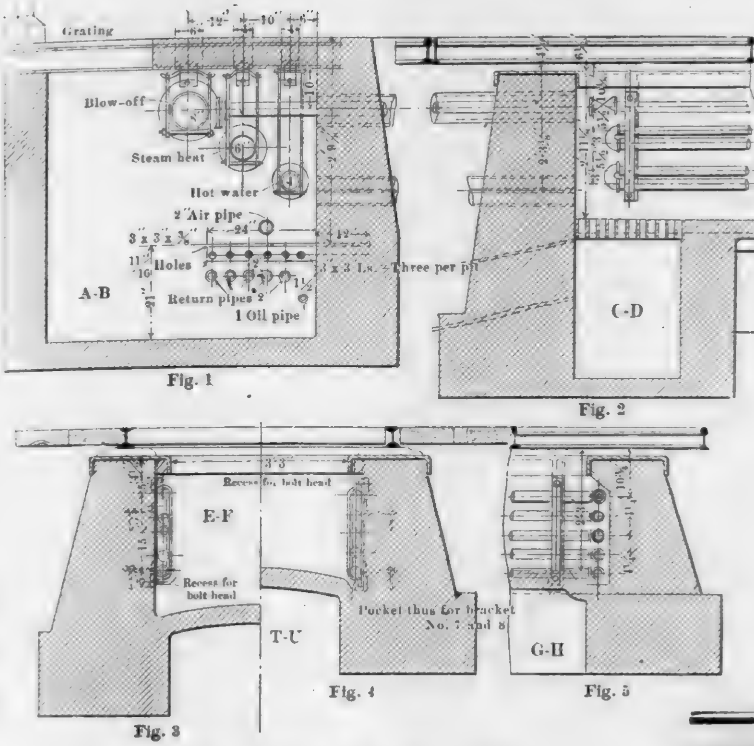

SECTIONS THROUGH PITS AND TUNNEL.

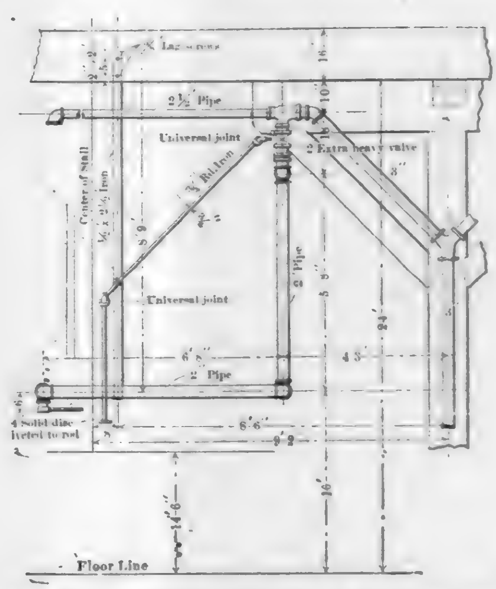

FIG. 8.—DOME CONNECTION FOR BLOWING OFF AND FILLING BOILERS.

A temperature of 60 deg. F. is guaranteed throughout all of the buildings in zero weather. All the ordinary pits have five coils of 2-in. pipe on each side and across the ends. On the outside wall beneath the windows a four-coil radiator, 20 ft. long, is placed opposite each pit. In the pits the pipes are protected by overhanging rail supports, as shown in the cross

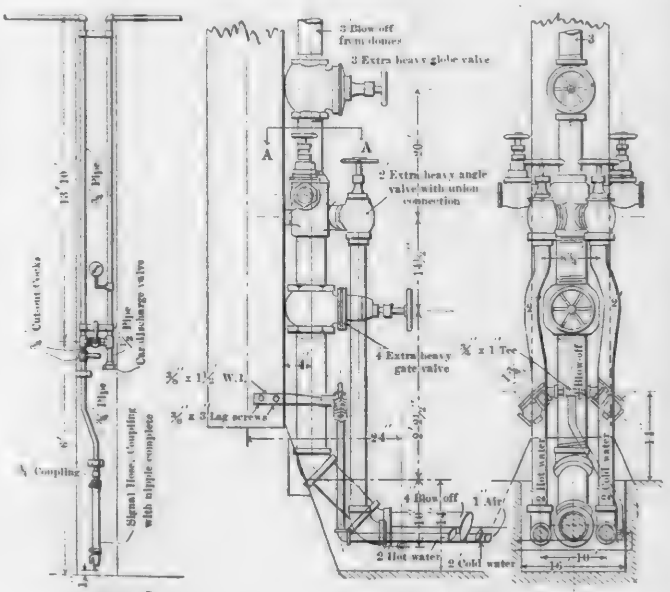

FIG. 6. FIG. 7.

PIPING FOR TESTING TRAIN SIGNALS AND POST MONITORS IN ROUNDHOUSE.

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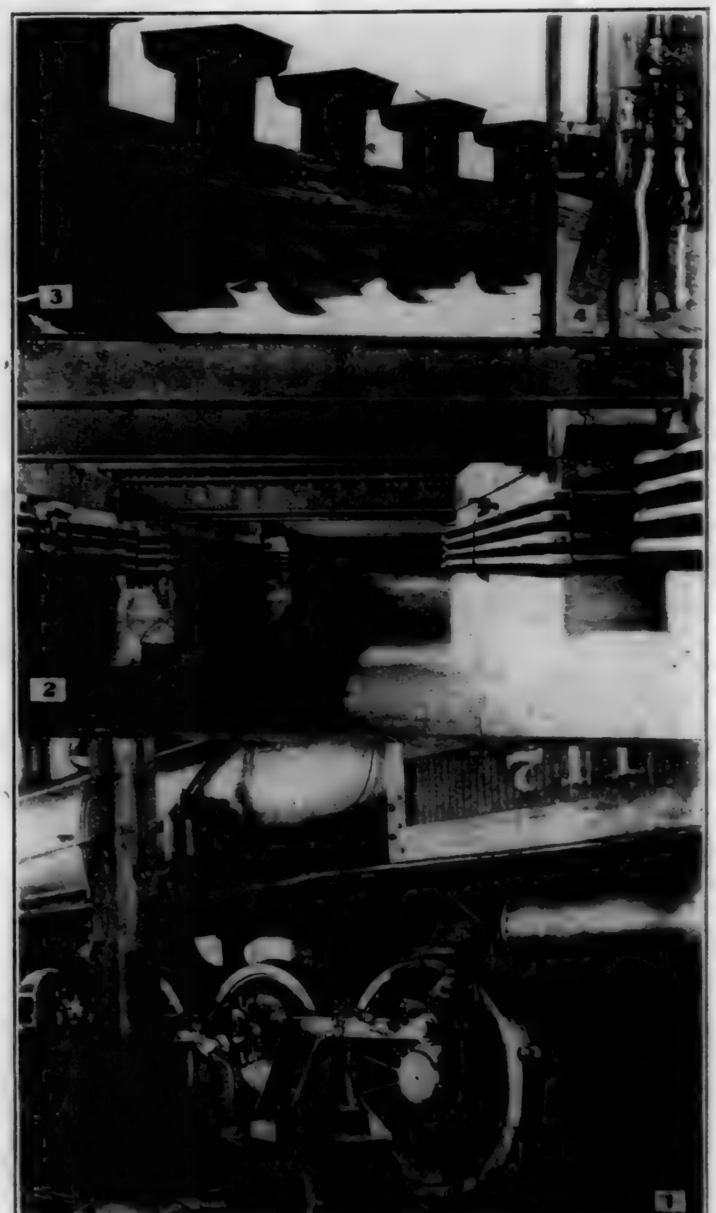

FIG 9.—(1) Blow off connection in use; (2) One of the drop pits; (3) Wire posts on roof; (4) Post pipe monitors.

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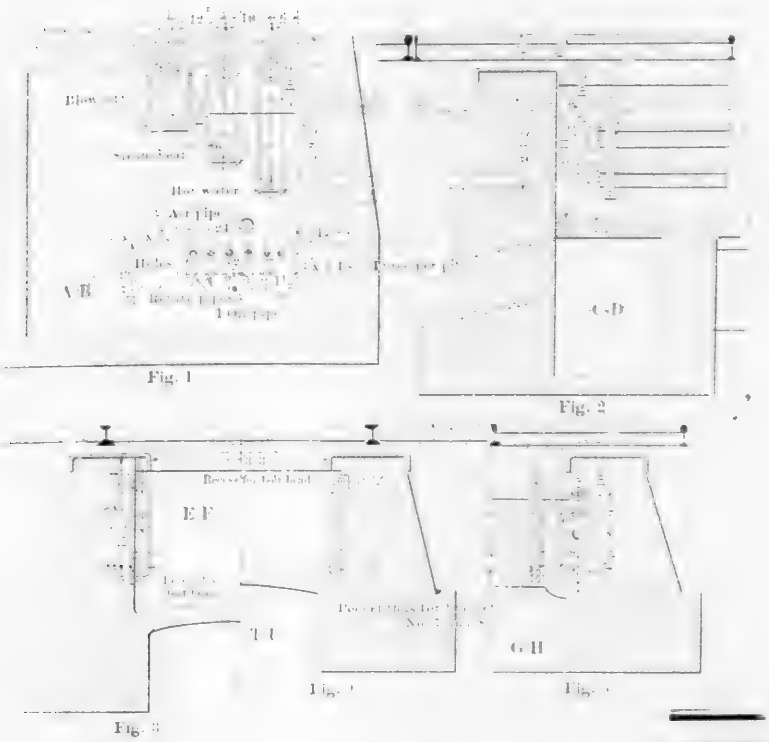

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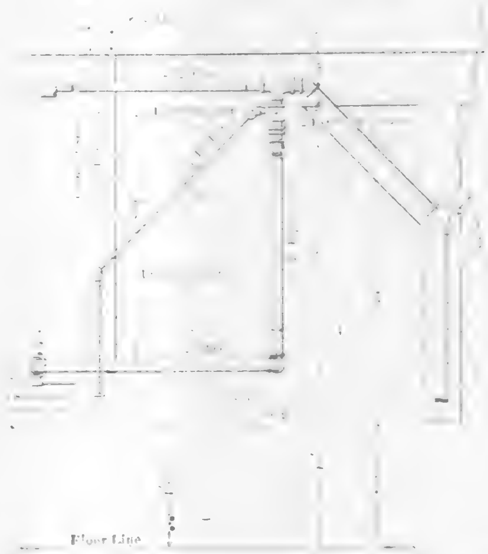

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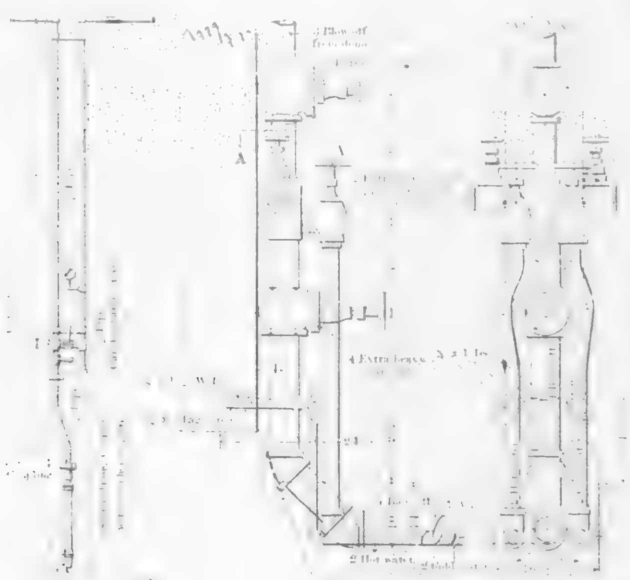

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PIPING FOR TESTING TRAIN SIGNALS AND POST MONITORS IN ROUNDHOUSE.

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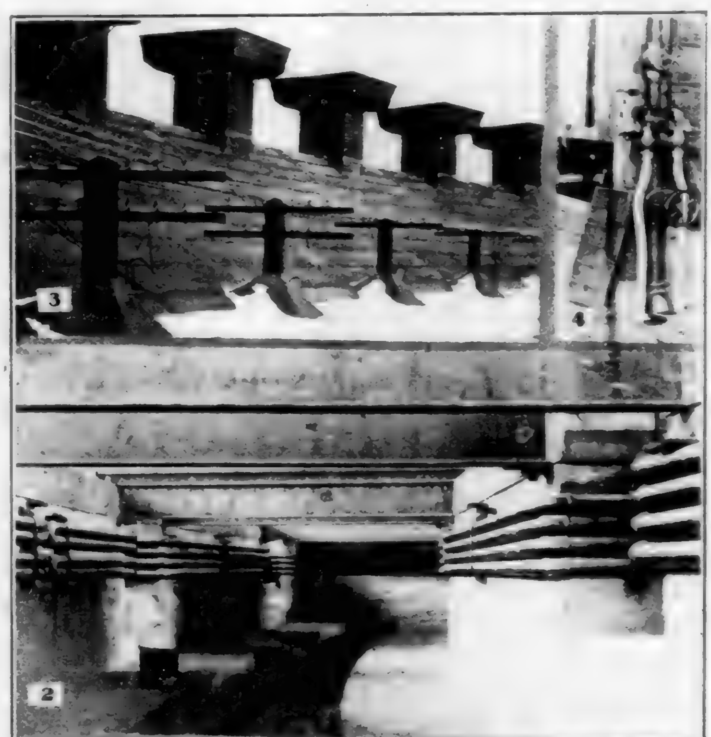

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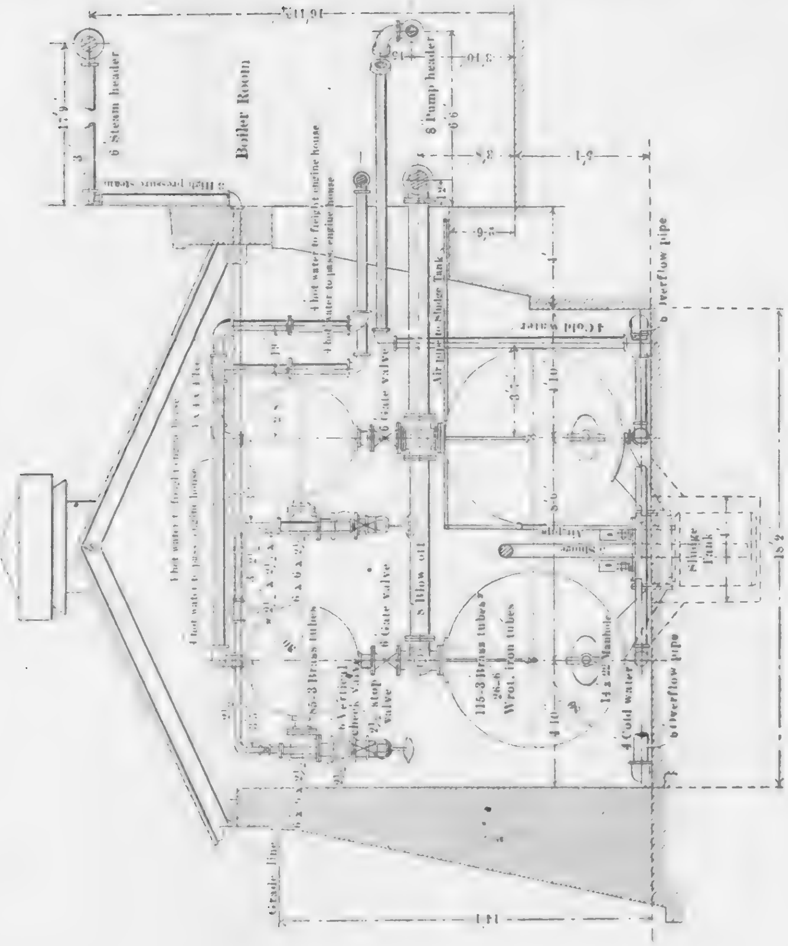


FIG. 11.

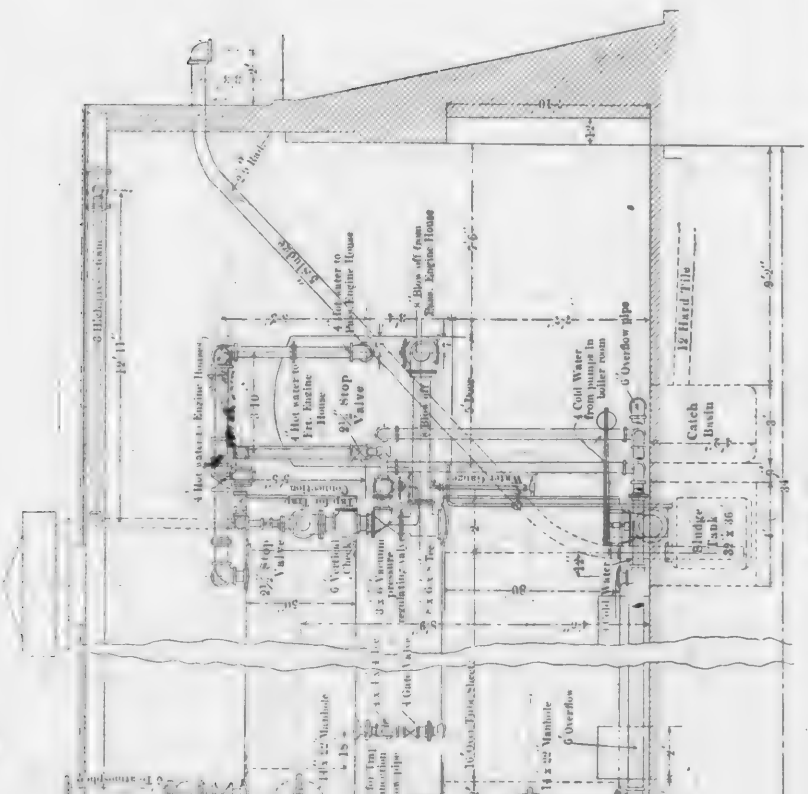


FIG. 10.

SECTIONS THROUGH POWERHOUSE ANNEX, SHOWING HEATERS.

the feed water heater in the boiler and used for feeding the boilers. Three lbs. bac pressure is used at the power house. steam pipe is run out to the ash pits fo use in thawing out ash pans when necessar

Calculations for the heating system wer made on a basis of 8 boiler h.p. per stall fo heating. There are 665 ft. of 2-in. pipe i each pit. One square foot of pipe heatin surface was allowed for 100 cu. ft. of volum of the roundhouses. Each stall has 475 s

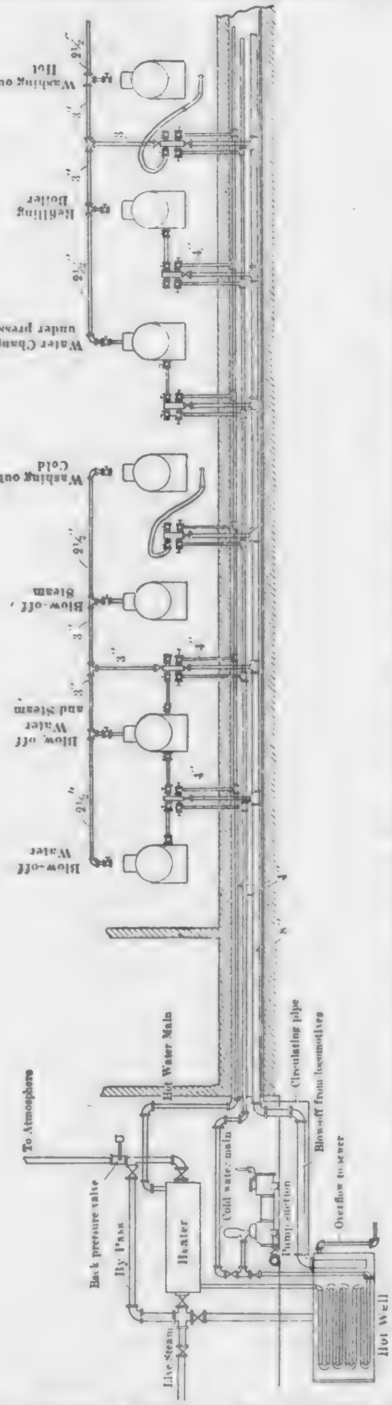


FIG. 12.—DIAGRAM SHOWING HOW WASH-OUT AND BOILER FILLING SYSTEM IS USED

ft. of radiating surface. For the office building, shop and other rooms a somewhat smaller proportion was allowed.

The washout, heating and other piping systems were designed by the mechanical department of the railroad company and were completely furnished and applied by the Erie Heating Company of Chicago. The ingenious assembling connections, or monitors, for the posts in the roundhouse, were devised by Mr. R. B. Kendig, mechanical engineer of the road.

LIGHTING.—The general lighting is by means of enclosed arc lamps at each post near the engine cabs. Sockets for portable connections are provided at each post, Fig. 9—(1), and at each side of each of the fire walls two incandescent lamps are provided and one receptacle for a plug. The wiring inside of the house is all protected in piping. The distributing mains pass around the roof outside of the building to posts over each pit, Fig. 9—(3), thus keeping the wires entirely out of the influence of the gases. Four arc lamps are used for inside lighting and 9 for outside. Electric power is at the present time secured from the Elkhart Electric Company. It is received at 2,200 volts, 7,200 alternations and 60 cycles and is transformed to 110 volts and 2-phase for lighting and 440 volts and 3-phase for the motors. A 20-h.p. motor operates the machine shop. Two 10-h.p. motors drive the two turntables and three motors are used at the coaling station and 20 h.p for hoisting coal and 5 h.p. for operating the mixer and 3 h.p. for hoisting sand.

DROP PITS.—Eight drop pits in all are provided, four driving and four truck pits in each house. These are arranged so that three independent driving wheel and three independent truck wheel pits are available in each, and one track in each house has a driving wheel and truck wheel pit upon the same track. These pits are equipped with pneumatic telescope air jacks, similar to those in use by the C., B. & Q. and C. & N. W. railways. The heating piping for the drop pits is continued on one side of all the pits in each house; the piping on the other side is cut up into sections at the drop pits and other pits; only one valve is used to control the heating; the outlets of this piping connect to the vacuum pumps. The purpose of so many drop pits is to prevent delays of engines which may require work on wheels or boxes. As stated in another paragraph a great deal of repair work will be done here.

SMOKE JACKS.—These jacks are of an original design, having a cross section 50 x 36 ins. at the roof, tapering to 108 x 36 ins. at the bottom, where the jack is flared to 12 ft. x 5 ft. 6 ins. An annular opening 6 ins. wide around the jack at the roof allows smoke and steam to escape out of the peak of the building. They are of wood, protected by asbestos paint and are very effective.

BOILER HOUSE EQUIPMENT.—Three 264-h.p. Cahall, horizontal water tube boilers furnish steam. They are equipped with shaking grates. The stack is steel, 125 ft. high with a concrete base 17 ft. nigh. It is lined its whole length with firebrick, backed by ordinary brick. A 200-ft. Franklin compressor furnishes compressed air and two Fairbanks-Morse duplex feed pumps with 7 and 4½ by 10 in. cylinders, such having a capacity for feeding 900 h.p. of boilers are supplied. Feed water is passed through a No. 26 Cochrane feed heater.

MACHINE SHOP EQUIPMENT.

1—16 in. by 6 ft. Davis engine lathe.
1—30 in. by 14 ft. Schumacher & Boye lathe.
1—24 in. Aurora sliding head drill press.
1—48 in. Dresses, plain radial drill.
1—48 in. by 8 in. Keystone grinder.
1—Oster hand pipe machine (1 to 4 in. pipe).
1—Hydraulic bushing press.
2—40 in. forges for blacksmith and coppersmith.
1—24 in. Flather shaper.
1—surface plate.
1—upsetting block.
1—anvil.
4—portable work benches.
1—1,000 lbs. jib crane (blacksmith).
1—200 lbs. Bradley compact hammer.
1—No. 3 Buffalo type B volume blower.
1—No. 3 Underwood portable cylinder head facing machine.
1—Underwood portable cylinder boring bar.
1—No. 2 Underwood portable crank pin truing machine.
1—26 in. Underwood valve seat planer.
2—3 ton Franklin portable hoists.
2—cranes for loading material on tender tanks.
Hyatt roller bearings for all line shafting.

These houses now turn an average of 161 locomotives per day. This shop equipment is intended to provide for all running repairs, such as changing tires, whole or parts of sets of flues, light repairs to machinery, necessitated by wear or accident, in fact, to take care of all but general repairs or frame breakages. All main line passenger locomotives between Toledo and Chicago and all through freight engines between these points will be washed out at Elkhart, this work being now concentrated here which was formerly done at Air Line Junction, Toledo and Englewood. By this concentration the forces will be brought together at Elkhart and the work of washing out and repairing will be greatly facilitated.

This is not an inexpensive roundhouse plant, but it is fully justified as a business proposition in the returns which will come from prompt terminal service and the saving of wear and tear of boilers incident to the usual methods of washing out. The admirable oil house system and other details will be described later.

MELTING ICE WITH HOT WATER.—A by no means unimportant additional advantage of this hot-water service at Elkhart has just been brought to our attention. In the recent cold weather an engine came in for roundhouse work on the machinery and tender trucks. It was a mass of ice, with tender springs rigidly frozen up and the motion work inaccessible from ice. The engine was wanted in an hour. Ordinarily, the ice would not be melted off in two or more hours. By turning a stream of hot water on it, the ice vanished in a few minutes, and the engine was ready in less than one hour.

BEST FORM OF ENGINE HOUSES.—In a report to the Association of Railway Superintendents of Bridges and Buildings, the following advantages of rectangular and round engine houses were enumerated:

Rectangular Engine Houses.—1. Economy of ground space occupied.

2. Uniform room at front and rear of engines while in house, making it easier to work on engines.

3. Economy in construction of walls, floor and possibly roof.

4. Economy in piping for heating, water, steam and lighting.

5. Opportunities for pit drainage, which could be straight, open drain under transfer table.

6. Erecting shop, machine and washout section can be in connection with engine house, and either can be utilized as circumstances may require, thus concentrating buildings, men and tools.

7. Only one, or perhaps two, outside doors required; less heating and repairs.

8. More open to inspection and more uniform light.

9. No trouble with turntable radial tracks in winter.

10. Less trouble with snow and ice in turntable pits and around engine house doors.

Circular Engine Houses.—1. Close proximity to turntable, making the despatching of engines a matter of very little delay.

2. The handling of one engine between house and turntable without any relation to any other part of the house.

3. Saving of expense of transfer table and cost of operating.

4. Economy of ground space when track approaches and outside turntable for rectangular engine houses are considered.

The steam roads on which electrification is clearly advisable include (1) Lines operating very frequent trains and having numerous stops. (2) Tunnel roads, where electrification is advisable for the sake of ventilation, irrespective of operating costs. (3) Terminals in large cities, especially if partly operated through tunnels. (4) Lines on which, from franchise or other conditions, the use of steam is not permissible.

That class in which electrification is at present inadvisable include (1) All trunk lines operating under usual conditions and normal distribution of passenger and freight traffic. Generally it may be assumed that trunk lines operating trains at greater than 30 minutes headway cannot show sufficient economies and gains of traffic by electrification to cover the interest and depreciation on cost thereof. With trains operating more frequently than with 30 minutes headway individual cases may merit detailed study. (2) Branch lines depending largely or entirely on freight traffic and other branch lines on which a very substantial increase in passenger traffic cannot be developed by such more frequent service as electric equipment would make readily possible.—*J. G. White, International Engineering Congress.*

REPORT OF COMMITTEE ON POWER.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

DESCRIPTIONS OF STANDARD TYPES OF LOCOMOTIVES.

(For previous article see page 40.)

The committee proposed seven standard locomotives as a basis for the purchase of power for these lines for the immediate future. These include a heavy and medium weight consolidation, two ten-wheel classes, Pacific type, Atlantic type and a six-wheel switcher. These locomotives are represented in the accompanying table of comparative dimensions, and five of the seven are shown in the outline diagrams.

HEAVY CONSOLIDATION.—This locomotive is recommended for very slow freight trains on grades as great as 1 per cent., its weight being up to the present capacity of bridges and tracks. This resembles locomotives already in service, but the committee recommends a reduction of steam pressure from 200 to 185 lbs., in order to reduce boiler repairs. (It should be noted that the committee recommends 185 lbs. boiler pressure for all their standard locomotives, with the exception of the Pacific type, which will be referred to again.) The heavy consolidation locomotive will be used for grades and coal traffic, where the movement of trains is slow, and where 57-in. wheels and a tractive effort of 40,000 lbs. will be required.

MEDIUM CONSOLIDATION.—This is a much lighter engine, and is recommended for use on a large portion of the lines where the condition of track and bridges will not permit of using the heavier locomotive. Its tractive effort is 36,200.

TEN-WHEEL DESIGNS.—Two 4—6—0 designs are recommended, so arranged that with no other changes, except in the diameter of the wheels, a passenger locomotive may be made available for fast freight service. This engine is not too heavy to be run generally over the entire system. With 69-in. drivers the tractive effort will be 28,680 lbs., and with 63-in. wheels it will be 31,400 lbs., giving a factor of adhesion of 4.24.

PACIFIC TYPE.—For very heavy passenger service on divisions with steep grades this type, with a deep firebox and large amount of heating surface, great steaming capacity, and high tractive effort, may be more generally depended upon than any other type of locomotive. The present Rock Island engine No. 801 (See AMERICAN ENGINEER, October, 1903, page 35) is taken as a basis for this design. The cylinders are 22 ins. instead of 21 ins.; the tractive power increased from 28,680 lbs. to 31,000 lbs.; the total weight from 195,000 to 203,000, and the trailing truck with an inside bearing gives place to one with outside bearings. The grates are 68 ins. wide, being uniform with the others.

ATLANTIC TYPE FAST PASSENGER.—This engine is similar to the C. & E. I. engines built at the Schenectady works, except that 73 instead of 79-in. drivers are suggested, the steam pressure is reduced to 185 lbs., and the firebox reduced to 68 ins. in width, so that standard grate bars may be employed. (The width of all fireboxes in this series of designs is uniformly 68 ins.) This engine is designed so that 79-in. wheels may be applied in future with as few alterations as possible. With the possibility of grade reductions, the elimination of grade crossings and the application of interlocking, the use of 79-in. wheels will probably be necessary in future, therefore it is desirable to provide for the change.

PROPOSED STANDARD LOCOMOTIVES.

COMPARISONS.

Design by number	1.	2.	3.	4.	5.	6.	7.
Class	2-8-0	2-8-0	4-6-0	4-6-0	4-6-2	4-4-2	0-6-0
Class by name	Consol.	Consol.	10-wheel	10-wheel	Pacific	Atlantic	6-wheel swi.
Gauge (ft. and ins)	4-8½	4-8½	4-8½	4-8½	4-8½	4-8½	4-8½
Weight on drivers	180,000	160,000	133,200	134,000	136,000	102,000	138,500
Weight on truck	20,000	22,000	43,800	44,000	33,000	42,500	......
Weight on trailer	......	......	......	......	34,000	37,500	......
Weight, total	200,000	182,000	177,000	178,000	203,000	182,000	138,500
Wheel base, driving	17-0	17-0	15-0	15-0	12-4	7-0	11-0
Wheel base, total engine	26-0	25-6	25-8	25-8	32-0	27-5½	11-0
Wheel base, total engine and tend.	59-9	58-3	57-2	57-2	62-2	58-8½	41-9½
Length over all	69-10	68-1	67-4	67-4	71-8	68-8½	57-5½
Cylinders, diameter by stroke	22 x 30	22 x 30	22 x 26	22 x 26	22 x 26	21 x 26	20 x 26
Cylinders, spread	88 ins.	86 ins.	86 ins.	86 ins.	86 ins.	86 ins.	85 ins.
Driving wheels, diameter	57 ins.	63 in.	63 ins.	69 ins.	69 ins.	73 ins.	51 ins.
Driving wheel centers, diameter	50 ins.	56 ins.	56 ins.	62 ins.	62 ins.	66 ins.	44 ins.
Driving wheel centers, material	Cast steel	Cast steel	Cast steel	Cast steel	Cast steel	Cast steel	Cast iron
Driving journals	10 & 9 x 12	9 x 12	9 x 12	9 x 12	9½ & 9 x 12	9½ x 12	9 x 12
Trailing wheels, diameter	......	......	......	......	49 ins.	45 ins.	......
Trailing journals	......	......	......	......	8 x 14	8 x 14	......
Engine truck wheels	33 ins.	33 ins.	30 ins.	33 ins.	33 ins.	36 ins.	......
Engine truck journals	6 x 12	6 x 12	6 x 12	6 x 12	6 x 12	6 x 12	......
Frames, width	4½ ins.	4½ ins.	4½ ins.	4½ ins.	4½ ins.	4½ ins.	4 ins.
Boiler, type	Ex. W. T.	Ex. W. T.	Ex. W. T.	Ex. W. T.	Ex. W. T.	Straight	Straight
Boiler, diameter o. d., first ring	70⅝ ins.	66 ins.	66 ins.	66 ins.	66 ins.	72 ins.	62⅛ ins.
Boiler, pressure	185 lbs.	185 lbs.	185 lbs.	185 lbs.	200 lbs.	185 lbs.	180 lbs.
Fire box, length and width	107⅛ x 67¼	96⅛ x 67¼	96⅛ x 67¼	96⅛ x 67¼	96⅛ x 67¼	96⅛ x 67¼	59⅛ x 67¼
Tubes, number of and diameter	383-2	320-2	331-2	331-2	300-2	320-2	234-2
Tubes, thickness	No. 11.	No. 11.	No. 11.	No. 11.	No. 11.	No. 11.	No. 11.
Tubes, length	15-6	15-10	14-2	14-2	18-7	16-0	15-0
Heating surface, tubes	3,092	2,639	2,441	2,441	2,919	2,667	1,828
Heating surface, firebox	Abt. 174	Abt. 155	Abt. 154	Abt. 154	Abt. 154	Abt. 154	108
Heating surface, total	3,266	2,794	2,595	2,595	3,073	2,821	1,936
Grate surface	50.0	44.89	44.89	44.89	44.89	44.89	27.8
Tractive power	40,000	36,200	31,400	28,680	31,000	24,700	31,200
Factor of adhesion	4.5	4.42	4.24	4.67	4.39	4.14	4.44
Center of boiler, from rail	114	116	111	114	113½	108	107½
Tender frame	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Tender wheel, diameter	33 ins.	33 ins.	33 ins.	36 ins.	36 ins.	36 in.	33 ins.
Tender truck, type	Arch bar	Arch bar	Arch bar	Arch bar	Arch bar	Arch bar	Arch bar
Tender journals	5½ x 10	5½ x 10	5½ x 10	5½ x 10	5½ x 10	5½ x 10	5 x 9
Tank, type	Water btm.	Water btm.	Water btm.	Water btm.	Water btm.	Water btm.	Sloping bk.
Tank, water capacity	7,000 gals.	7,000 gals.	6,000 gals.	6,000 gals.	7,000 gals.	6,000 gals.	4,500 gals.

SIX-WHEEL SWITCHER.—The present Rock Island heavy switching engine has proved satisfactory and suitable for the general conditions. The proposed engine is generally similar in all respects. The following recommendations have been made to apply to all engines:

STANDARD DIMENSIONS RECOMMENDED GENERALLY FOR ALL ENGINES.

DRIVING WHEEL CENTERS.—44-in. diameter, cast iron; 50-in. diameter, cast iron, except main; 56-in. diameter, cast steel; 62-in. diameter, cast steel; 66-in. diameter, cast steel; 72-in diameter, cast steel.

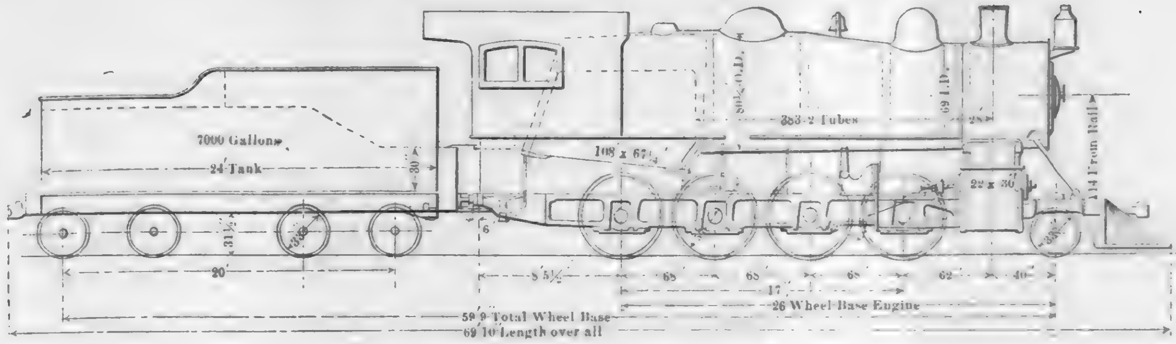
Distance between all driving weel hubs, 55 ins.

TIRES.—All tires Master Mechanics' standard contour and flange 5½ ins. wide. All driving tires 3½ ins. thick.

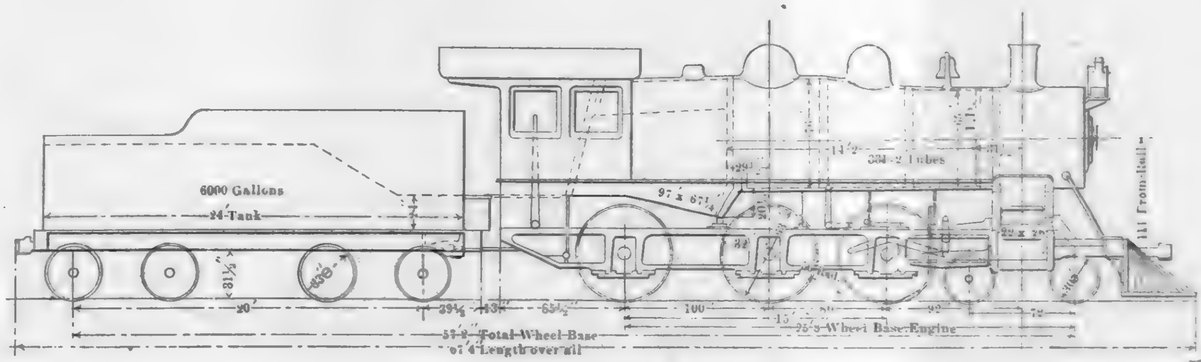
DRIVING AXLES.—Wheel fit ½ in. larger than diameter of journal.

JOURNAL BOXES.—End play made by reducing width of box; 9 x 12 ins., 9½ x 12 ins., 10 x 12 ins. All sizes to be designed for 5-in. width of frame.

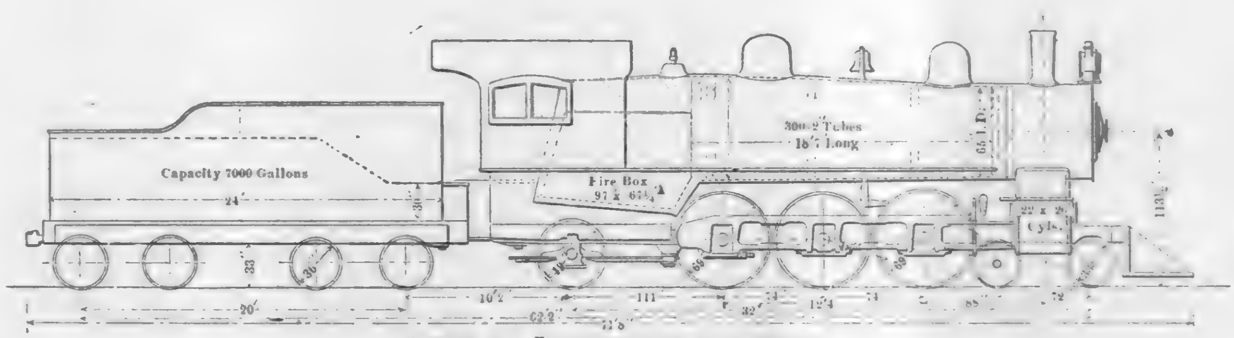
ENGINE TRUCKS.—Distance between hubs of wheels, 52 ins.



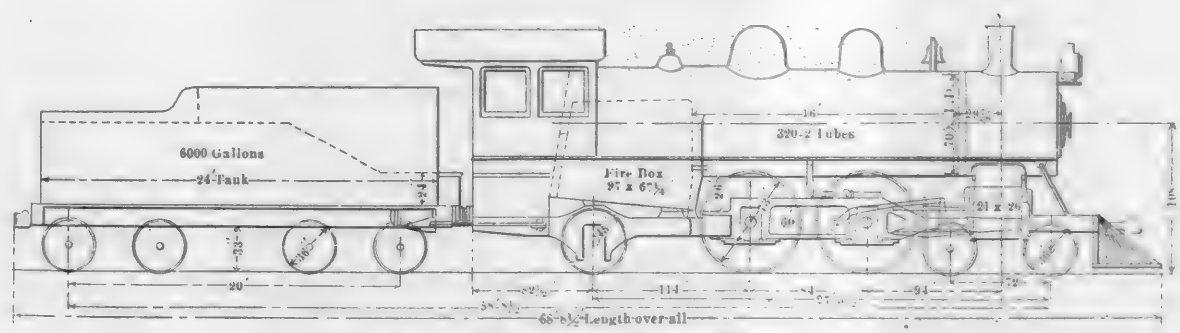
DESIGN NO. 1.—HEAVY CONSOLIDATION.



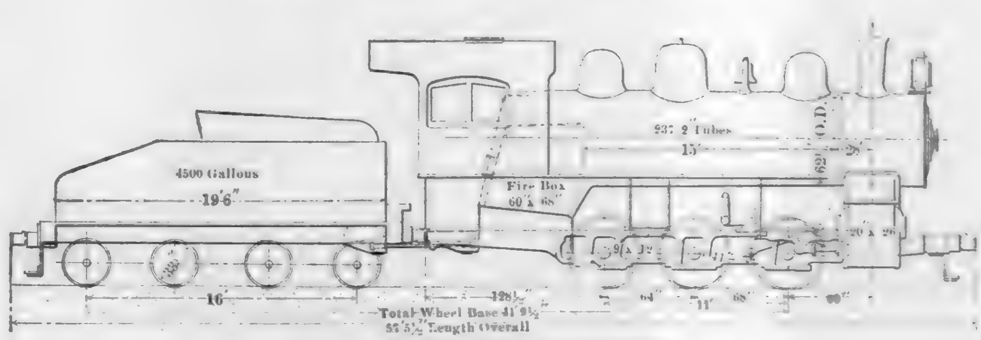
DESIGN NO. 3.—10-WHEEL PASSENGER.



DESIGN NO. 5—PACIFIC TYPE PASSENGER.



DESIGN NO. 6.—ATLANTIC TYPE PASSENGER.



DESIGN NO. 7.—6-WHEEL SWITCHER.

STANDARD DESIGNS ADOPTED BY ROCK ISLAND POWER COMMITTEE.

Nominal outside diameter of wheels, 30 ins., 33 ins. and 36 ins. Actual diameter of centers, 24¼ ins. for 30-in.; 27¼ ins. for 39-in.; 30¼ ins. for 36-in.. Journals, 6 x 12. Wheel fit, ½ in. larger than diameter of journals. Wheel hub, 7 ins. thick.

BOILER.—Radial stay. Staybolts, ⅞-in., spaced 3½-in. centers. Outside rows may be 1 in. Flues, 2 ins. in diameter. Spaced 2⅞ ins. at firebox; 2¾ ins. may be used at front flue sheet, if necessary. Water space, 4½-in. sides, back and front. Width of all fieboxes to be 68 ins., inside ring.

TENDERS.—For switching engines, 4,500 gals.; tank sloping back 19 ft. 6 ins. x 9 ft. 10 ins. For road engines, 6,000 gals., tank 24 ft. x 10 ft.; 7,000 gals., tank 24 ft. x 10 ft. All dimensions inside plates.

TENDER TRUCK AXLES.—M. C. B. standard, with journals 5 x 9 ins. for 4,500 gal. tanks, 5½ ins. x 10 ins. for 6,000 and 7,000-gal. tanks. Center of gravity of the tenders to be kept as low as possible. Consider height of 31½ ins. from top of track to underside of channels for frames having 33-in. and 36-in. wheels.

CABS.—All engines to have steel cabs. Consider present Rock Island practice.

CYLINDERS.—Transverse centers 85 ins. for switchers, 86 ins. for Atlantic, Pacific, medium consolidations, mogul and 1 wheel engines, 88 ins. for heavy consolidations.

FRAMES.—Center to center for frames, 43 ins. for all engine using 12-in. boxes.

STANDARD TAPERS.

Bolts, 1-16 in 12.

Piston rods for crossheads and piston ends, ¾ in 12.

Wrist pins in crossheads, ¾ in 12.

Eccentric rod pins in link, ¾ in 12.

Mud plugs, 12 threads, ¾ in 12.

Brass fittings screwed in boiler, 12 threads, ¾ in 12.

(To be continued.)

LOCOMOTIVE WIND RESISTANCE.—By applying Mr. Aspinall' formula ($P = 0.003V^2$) Mr. C. F. D. Marshall, in a communica tion to *The Engineer*, has worked out the resistance due to th air against an area of 16 sq. ft. of an English locomotive fron end as follows:

Speed miles per hour.	Pressure in lb. on 16 square feet.	Additional horse-power required.
50	120	16
60	172.8	27.6
70	235.2	43.9
80	307.2	65.5
90	388.8	93.3
100	480	128

WATER SOFTENING.

CONTROL AND RESULTS FROM A CHEMICAL STANDPOINT.

BY G. M. CAMPBELL, P. & L. E. R. R.

(*Continued from page* 52.)

After the weekly reports are received and the samples forwarded to laboratory are tested, a summary report is made out. A sample report for the week ending October 29, 1904, is shown in Fig. 4, size of sheet being 8 x 10½ ins. This report is for record, the daily and weekly reports are for temporary use. Special attention is directed to the column "Average charge, pounds per 1,000 gallons." As explained in the foot note the first figure shows the actual amount used per 1,000 gallons, this, multiplied by the amount of water pumped gives the total amount of soda or lime used. The second figure gives the amount actually used by the attendant for each 1 deg. per 1,000 gals. and the third figure the amount that the table calls for for each 1 deg. The relation between the second and third figures shows whether or not the attendant is attending properly to the charging; a small variation is allowable and is expected, for example, 5 charges may have been put in during one week and water for only 4½ charges put through; the next week the balance would probably be on the other side. The soda rate for all the plants except Whitsett Junction was changed at end of October to 0.100 lbs. per 1 deg. per 1,000 gals. The lime rate is apparently very high at McKees Rocks; this is due to the fact that the acidity is not taken into account, if it was the rate would be the same as the others. The lime rate in the sample report is slightly high at all points. It has

THE PITTSBURGH & LAKE ERIE RAILROAD COMPANY

SUMMARY REPORT OF WATER SOFTENING PLANTS

For week ending Oct. 29" 1904

PLANT	WATER Gallons Pumped Hours Pumping	†Average Charge. Lbs. per 1000 Gals. Soda	Lime	DAY	TESTS RAW WATER Hardness Pumper	Chemist	*Alkalinity Pumper	Chemist	Acidity Pumper	Chemist	TREATED WATER Hardness Pumper	Chemist	Alkalinity Pumper	Chemist	Causticity Pumper	Chemist
Buena Vista		3.363	1 309	Mon	25	23	*8	*9½	38	34	3	3	12	11	12½	11
	252,343	106	.075	Wed	24	23	*9½	*10½	39	36	3	2	8½	9	10	7
	(14 25)	100	071	Fri.	23	21	*7	*8	29	26	3	2½	13½	12½	13	13
Groveton		1 409	843	Mon	26	25	9½	9	5	4	6	6	9	8	11	10
	738,411	093	067	Wed	26	25	9½	9	3	2	6	6½	8½	8	9½	9½
	(30 15)	100	070	Fri.	24	23	10	9	4	3	6	7	9	8½	10	9½
Massillon		804	1 306	Mon.	21	23	14	13	4	3	7½	8½	8	7	9½	6½
	2,264,000	.116	072	Wed.	21	25	14	14	4	3½	7	8½	7½	8	10½	8
	(122)	112	069	Fri.	21	26	14	13½	4	3½	7	9	8½	8	13	7½
McKees Rocks		2 353	2 213	Mon.	42	40½	22	22		6	6	6	4½	5	5	4
	3,340,000	.117	100	Wed.	42	40½	22	22		6	6	6½	5	5	5	4
	(35 20)	117	100	Fri.	42	42	22	22		6	6	6½	5	5	5½	4
New Castle Junction		1 523	644	Mon	17	16	6	6	2	1	6	5	8½	7½	8½	7½
	735,000	.112	071	Wed	17	16	7	7½	2	2	6	6	8½	8	9	8
	(36 45)	109	072	Fri.	17	16	6	6	2	1	6	5½	9½	9	10	9
Pittsburgh		2 558	779	Mon	24	22	*.3	N	9	8½	5½	5	7	7	7	7
	708,750	114	067	Wed	21	22	N	N	11½	10	4½	5	8	8½	6	6
	(44 55)	105	.071	Fri	27	25	*7	*6	13	12	7	6½	6½	7	3	3½
Rock Point		985	434	Mon	17	20	6	7	2	1½	6	6	5½	6	6½	6
	536,666	.088	064	Wed.	17	20	6	7½	2	1	6	7	5½	6½	7	6½
	(26 50)	100	071	Fri	17	19	6	7	2	1½	6	6½	6	6½	7	6½
[illegible]		483	.511	Mon	8½	8½	3	3½	5	5	4	3½	6½	6	11½	9
	140,000	086	062	Wed	8½	8½	3	3½	6	4	4½	4	6½	6	9	8½
	(37)	097	069	Fri	9	8½	3	4	6	3½	4	4	6½	6½	10½	9
Whitsett Junction		669	1 232	Mon	23½	25	16	15	2	3½	7	6½	7	6½	9	6½
	236,548	088	067	Wed.	24	25	16	15	2½	3½	7	7	7	6½	9	6½
	(29)	083	072	Fri	24	26	16	15	2½	3½	7½	7½	7½	6½	9½	6½
Williamsb'g		2 651	1 109	Mon	24	24	1	1	12	11½	4	3	7½	6½	10½	10
	387,886	108	077	Wed	26	24	*1	*1	15	14½	6		4		4	
	(35)	100	072	Fri.	26	24	*1	*1	15	13	8	6	4	3	3½	3
Total	10,044,554															

* When Raw Water is Acid to Methylorange, it is marked with an asterisk (*).

† In Soda and Lime columns figures are 1st amount charged 2d. amount charged per 1°: 3d. amount that should have been charged per 1°.

REMARKS:

E CALVERT

Chemist

G. M. Campbell

FIG. 4.—SUMMARY REPORT SHEET.

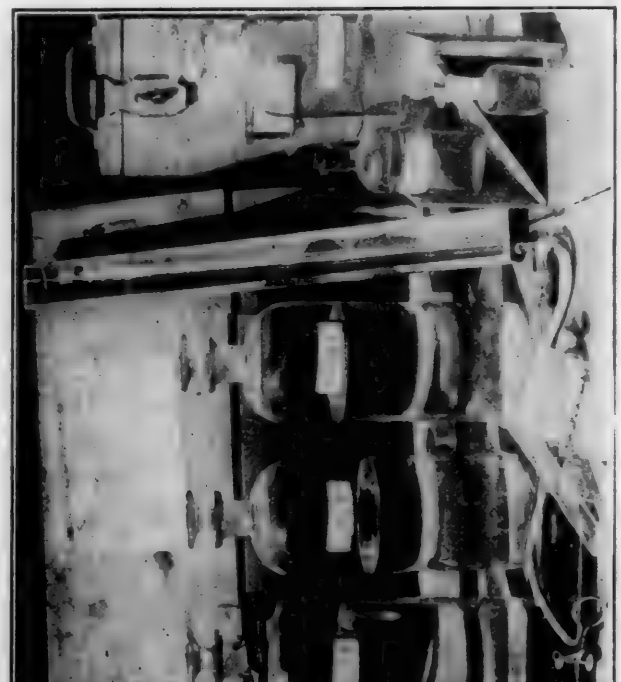


FIG. 5.—TRAVELING CASE WITH TESTING OUTFIT AND CHEMICAL SUPPLIES.

been reduced to about 0.056 lbs. per 1 deg. per 1,000 gals., h is nearly the minimum allowable with 85 per cent. lime. soda rate may also be somewhat reduced, perhaps down about 0.096 lbs. per 1 deg. per 1,000 gals. The figures for dness, etc., under word "Pumper" are from the weekly re-t sheets, those under "Chemist" are obtained from the tests samples shipped to the laboratory. A certain variation is pected in the raw water, owing to the matter in suspension in sample tested at the softener, which has settled out in the ample sent to the laboratory. The "Acidity" which partly or holly represents free carbonic acid is, as might be expected, most uniformly lower in the laboratory sample. A glance this summary report conveys a very comprehensive idea of the general working of all the plants; on it are based all anges in treatment, censure or praise of attendant, etc.

Chemical supplies for the various plants are forwarded at gular intervals in a special case which contains a complete testing outfit and a supply of all chemicals. The attendant upon receipt of the case takes out what material he requires to replace broken material and puts into the case the broken parts. To renew his supply of chemicals he takes the full bottles out of the traveling case and retains bottle and all; he puts back in the case the old bottles with the balance of the chemicals they contain. In this way every plant is kept supplied with fresh chemical solutions accurately standardized, and there is no danger of the solutions ever being poured into the wrong bottles or otherwise becoming inaccurate. This traveling case is the middle one in Fig. 3. The apparatus carried in it and the case lying on its side are shown in Fig. 5; size of case is 21½ x 14 x 9 ins. The left hand case in Fig. 3 is for distilled water, which is sent out oftener than the other solutions.

By means of the summary report and the traveling supply cases, the quality of the water turned out, the condition of the testing outfit and the general operation of the plant are known with such certainty that it frequently happens that some of the plants are not visited for months at a time. The system of control as outlined may appear at first glance to be intricate, difficult to follow and costly in operation, but the reverse of this is the case; its workings must indeed be smooth and accurate when such excellent results are obtained with a very minimum of personal inspection. The system of control is almost automatic in its operation and works with a precision that is remarkable when it is considered that nearly all the work is done by unskilled men who have absolutely no idea of what chemistry is, and yet who work with a minuteness and accuracy of observation that is hard to surpass; many of them give results differing from the laboratory by not more than ½ deg. or 1 part in 200,000. In the light of such results as have been obtained on the Pittsburgh & Lake Erie Railroad, it is safe to say that with a machine which is fairly accurate in its operation, accurate and definite chemical results can be obtained with any water by any man of ordinary intelligence without the assistance of a chemist except for the occasional analysis of the treated water simply as a check to make certain that results thought to be obtained are actually obtained.

Very much has been written concerning water treatment and the proper chemicals to use; all authorities agree that for general purposes the only available chemicals are dehydrated sodium carbonate, usually known as soda ash, and calcium oxide, usually known as unslaked lime; these are used in preference to all others simply because they are the cheapest chemicals which will do the work. If soda ash and lime are used, a fixed and definite amount is required to change a water from one condition to another and this amount is absolutely independent of the machine. It is frequently stated that a smaller amount than is required by the chemical equations will answer; this statement is entirely incorrect. At the same time, all classes of machines are not equally efficient, there is often a great waste of lime in continuous plants due to the lime being run to sewer before it is all used, there is sometimes much waste in soda also, owing to the irregular action of the proportioning devices and a consequent frequent surplus of soda. With a machine, working with good commercial accuracy, the chemical cost of water treating depends altogether on the initial quantity of the water and the price of soda ash and lime. Soda ash at present, December, 1904, costs f. o. b. Pittsburg, 0.78 cents per lb., and lime 0.42 cents, allowing an average of 185 lbs. of lime per barrel. The cost of treating any water is found by obtaining from the summary report sheet the amount of lime and soda used per 1,000 gals. and multiplying by the values above. The costs per 1,000 gals for the 10 plants for the sample week given are: Buena Vista, 3.17 cents; Groveton, 1.45 cents; Haselton, 1.18 cents; McKees Rocks, 2.76 cents; New Castle Junction, 1.46 cents; Pittsburg, 2.32 cents; Rock Point, 0.95 cents; Stobo, 0.58 cents; Whitsett Junction, 1.04 cents; Williamsburg, 2.53 cents. This gives a weighted average for all plants of 1.85 cents per 1,000 gals. The waste at these plants does not at present (December) exceed 3 per cent., it will later be still further reduced. To obtain the total cost per 1,000 gals., the cost for pumping and for attendance should be added; these costs will vary according to the height the water has to be pumped and the number of gallons pumped, neither item being appreciably increased with a continuous process by reason of the softening. At McKees Rocks, where water is pumped by a motor-driven turbine pump, the cost for pumping averages about 0.4 cents, and the cost for attendance about 0.4 cents, or a total of 0.8 cents per 1,000 gals. The cost for treating the well water at that point is rather high. When the river water is used it is expected that the average cost for treating will not exceed 0.7 cents, so that the total cost will then be about 1.5 cents per 1,000 gals., a very cheap water.

The general results from a chemical standpoint may be judged from the following figures compiled from the weekly summary reports for the two worst months, September and October, of the present year. Figures are the weighted average each week for the output of all 10 softeners:

Week ending	Raw Water. Hardness.	Treated Water Hardness.	Treated Water Alkalinity.	Treated Water Causticity.
Sept. 3, 1904	24.20	6.08	5.96	5.98
" 10, "	25.60	5.57	6.50	6.25
" 17, "	26.36	6.06	6.54	6.94
" 24, "	25.12	6.13	6.49	6.31
Oct. 1, "	26.05	5.45	6.23	6.96
" 8, "	25.62	5.26	6.33	6.98
" 15, "	26.64	6.54	6.87	6.50
" 22, "	26.38	5.92	6.18	6.57
" 29, "	27.27	6.03	6.50	6.31

The general average for the two months is: Hardness, 5.89; alkalinity, 6.40; causticity, 6.53. During these two months the total amount of water treated was almost 100,000,000 gals. The maximum variation in the treated water in the weekly averages for hardness, alkalinity or causticity was about 1 deg. or 1 part per 100,000. During these two months limiting variations in hardness of the raw and treated waters were:

	Raw Water. Degrees.	Treated Water. Degrees.
Buena Vista	13 to 44	3 to 9½
Groveton	19 to 25	4½ to 7½
Haselton	13 to 26	5 to 9½
McKees Rocks	40 to 42	4½ to 8
New Castle Junction	11 to 18	5 to 8
Pittsburg	17 to 35	3 to 7½
Rock Point	14 to 20	5 to 8
Stobo	8½ to 10½	3½ to 5
Whitsett	19 to 26	4½ to 7
Williamsburg	19 to 24	3 to 7½

The maximum hardness of treated water did not usually coincide with maximum hardness of raw water. The high hardness in the treated water was not necessarily scale forming, as that depended on the corresponding alkalinity. The hardness of the treated water may seem somewhat high, as for example 9½ deg. at Buena Vista, but it must be remembered that this was the worst figure obtained during two months when the raw water at times fluctuated violently. It was only occasionally that the hardness of the treated water got above 6½ deg., or about 3.8 grains to the gallon.

From the general averages it would at first sight appear that about 80 per cent. of the scale-forming material was removed. Actually fully or almost 100 per cent. of the scale-forming material is removed, when the hardness of the treated water is equalled or exceeded by the alkalinity and the alkalinity equalled or exceeded by the causticity. Water of the composition of the average for weeks ending September 10, September 24, October 15 or October 29 would form absolutely no

scale; that for weeks ending September 17, October 1, October 8 or October 22 might or might not form scale, if scale was formed the amount would be extremely small; that for September 3 would theoretically form a minute amount in boilers under high steam pressure. The 6 deg. of hardness left in the water forms a non-adhesive precipitate which is washed out or blown out as sludge. From an examination of the sample report for week ending October 29, the following information may be obtained. During the week, in treating the 10,044,554 gals., there were neutralized or removed about 250 lbs. of sulphuric acid, about 2,500 lbs. of carbonic acid gas, about 17,000 lbs. of hard scale-forming matter, such as sulphate of lime and magnesia, and about 4,700 lbs. of soft scale-forming matter, such as carbonates of lime and magnesia, and also much mud (not shown on report). There remained in the treated water about 5,000 lbs. of carbonates of lime and magnesia which would not form scale in the absence of the sulphates of lime and magnesia and which would be precipitated as sludge. About 20,000 lbs. of sodium sulphate, a completely soluble non-scale-forming substance were formed in the water, besides small amounts of common salt. The chemicals used were 16,639 lbs. of soda and 13,662 lbs. of lime.

Water has been and is now being treated on the Pittsburg & Lake Erie Railroad in such a way that it will form absolutely no scale, and no deposit in injector pipes or pumps. During the present year (1904) not one locomotive has been reported with clogged injectors. As an example of the working of the water, attention may be directed to the six B. & W. 250-h.p. water tube stationary boilers, working at 150 lbs. pressure, in the McKees Rocks power house. In the end of the year 1903, when from reasons chiefly of policy, the water was not fully treated, hardness being from 9 to 10 and alkalinity from 5 to 6, 56 boiler tubes were burnt out, due to the presence of scale, despite the fact that the boilers were in service only 10 days at a stretch and that the tubes were thoroughly cleaned out each time with a turbine flue cleaner. After the water was fully treated, this trouble absolutely ceased, and all work on the boilers was discontinued. The boilers are now run from 5 to 6 weeks and remain entirely free from scale. At the power plant at Pittsburg similar boilers were in use for about 3 years before the softener was installed, and had accumulated a considerable thickness of scale; this scale was entirely removed by the treated water and now the boilers run perfectly clean. In the locomotives troubles from corrosion have entirely ceased; no scale whatever is formed and much of the old scale is removed; these remarks apply of course only to such locomotives as get only treated water. There is some trouble from "foaming," or more properly, "priming," but considering the extremely bad condition of the raw waters and the consequent large amount of soluble salts left in the water the number of engine failures due to priming is very small. The trouble is kept at a minimum by means of the Raymer hot water washing-out appliance (AMERICAN ENGINEER AND RAILROAD JOURNAL, November, 1904), by means of which the locomotive has its water frequently changed, without any delay or racking of the boiler, due to contraction and expansion. The point where a water begins to prime is a very indefinite one, some locomotives have been reported "foaming" when the soluble salts did not exceed 75 grains to the gallon, others on exactly similar service have been satisfactory with 250 grains to the gallon. In the stationary boilers at McKees Rocks, where the boilers are free from scale, the soluble salts have reached 600 grains to the gallon with no "priming" whatever. There is also some trouble due to leaky flues and staybolts, but small when compared with troubles on other roads in the Pittsburg district. The water is absolutely non-corrosive and the present troubles due to leakage should not be assigned to the water unless it is that the purified water removes the scale which would otherwise help to close up openings. The troubles arise mostly from mechanical causes, not chemical, and the question will be solved along that line. A better design of fireboxes, a better system of firing, protection to the flue sheet from draughts of cold air, more care in cooling down boilers and more care in use of injectors, will greatly tend to remedy this trouble. Data on engine failures due to foaming and leaking will probably be published as soon as sufficient have been obtained.

(To be continued.)

HYDRAULIC SHEARING PRESS FOR COUPLER POCKETS.

To move old couplers to the shops or to cut out the pocket rivets by hand are expensive operations. The machine illustrated was designed by Mr. R. D. Fildes, machine shop foreman of the Lake Shore & Michigan Southern at Englewood, Ill., so that the power could be taken to the work and the pocket rivets sheared off as rapidly as the couplers may be handled by the attendants. These machines have been in use at Englewood, Collinwood, Toledo and Ashtabula for three years, and they are available wherever an air pipe can be taken. At these points they are located at the scrap bins. Their work is quicker than that of a hammer, and the rivet heads do not fly. These machines are also used as forging presses for a variety of heavy work on car material.

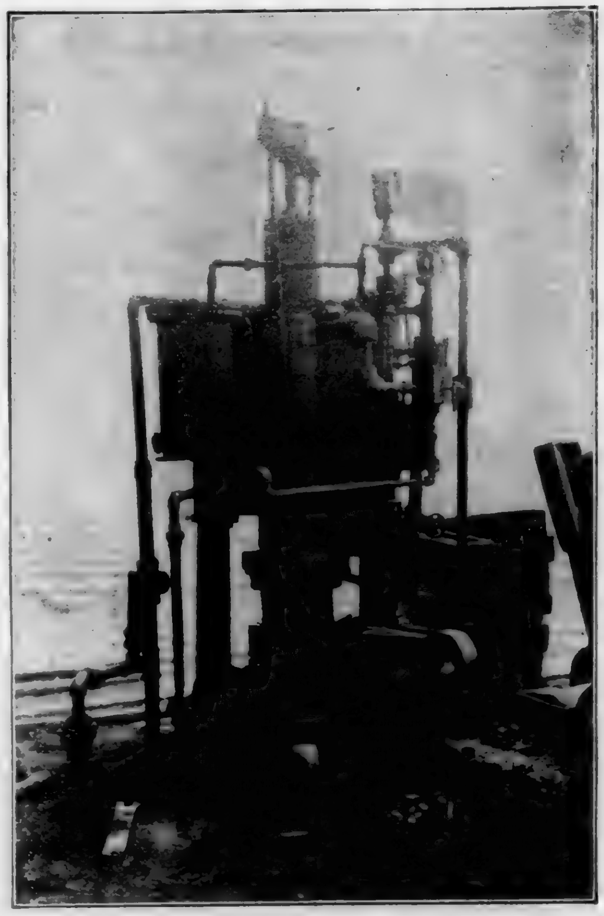


FIG. 1.

A photographic view is shown in Fig. 1, illustrating a broken coupler shank, with the pocket attached. The machine is heavy and does not break down; neither does it require skilled labor. At the right, in Fig. 2, an air cylinder is shown. This receives air from the throttle, through a self-actuated, reciprocating valve, and the extended piston rod of the air cylinder operates two hydraulic pumps above and below the air cylinder. These pumps give a pressure of 200 tons to the press plunger with an air pressure of 100 lbs., this being sufficient to shear off two 1⅛-in. rivets in two places, and do it quickly. By means of the three-way cock, shown at the left in Fig. 3, the main plunger cylinder is filled with oil from the reservoir shown at the left in Fig. 2, thus forcing the main plunger quickly to its work with the air pipe pressure only. Another movement of this valve starts the air pump and increases the pressure for the cutting portion of the stroke. The return stroke is made rapidly by means of direct air pressure through the pull-back cylinder on top of

the machine. The pull-back piston raises the main hydraulic plunger by means of the yoke and rods.

In operation, thin blocks are placed at the sides of the housings in Fig. 2. The pocket rests on these, and a square block is placed on top of the coupler shank. The plunger pushes the coupler down through the pocket, shearing off the rivets. The operation of the threeway cock in closing the air supply to the pump applies air to the lifting cylinder, and lifts the plunger for its next stroke.

These machines are adapted to a large variety of work in the blacksmith shop, as well as to the shearing of pocket rivets.

INTERESTING USE OF COMPRESSED AIR.—The explosion in one of the turrets of the United States battleship "Missouri," which occurred with fatal results last Spring, is now being guarded against by the use of compressed air. The explosion

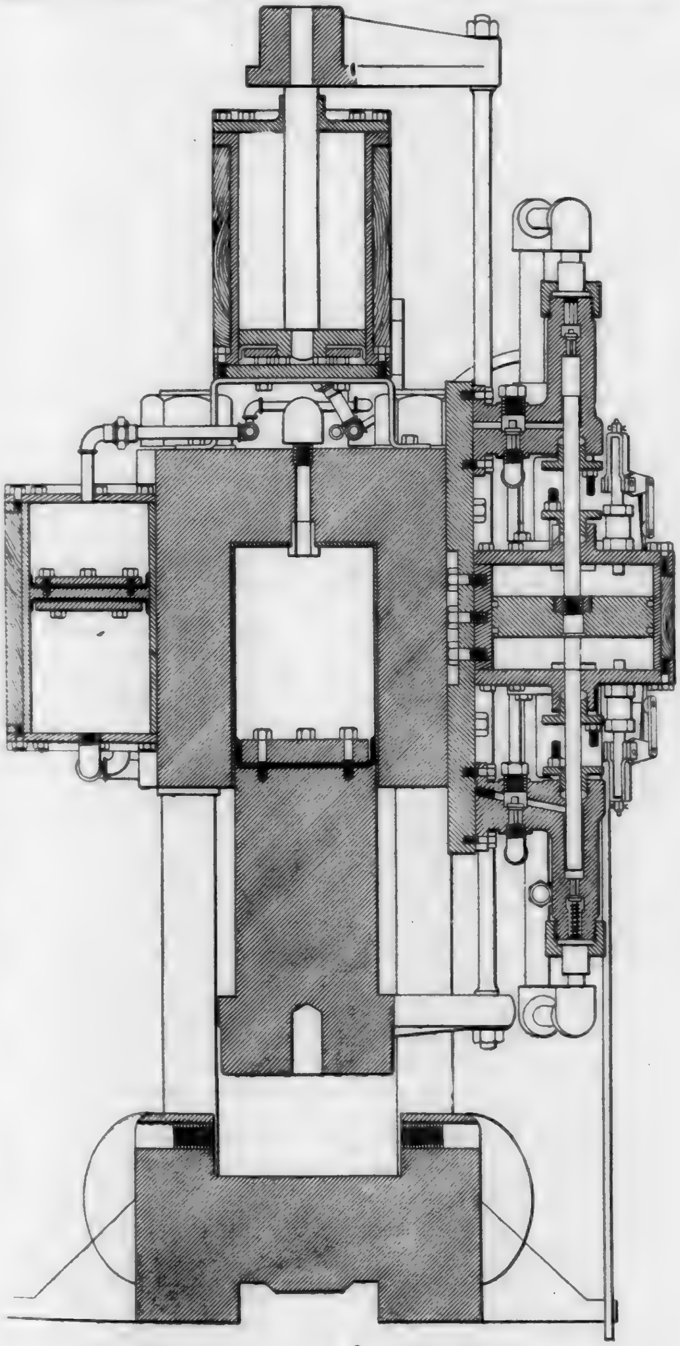


FIG. 2.

was supposed to have been due to the presence of sparks in the gun after firing, these sparks having ignited the charge of explosive which was placed in the gun for the next shot. The explosion communicated to the magazine below the turret, causing fatal results there, as well as in the turret itself. Compressed air from an electrically driven blower was used to clear the gun after each shot; now, however, the pressure is increased to 100 lbs. per sq. in., which is believed sufficient to insure against recurrence of the accident.

LINSEED OIL PAINTS.—It would perhaps be too strong a statement without limitation, but we cannot help feeling that our experiments seem to indicate that it is going to be difficult, not to say impossible, to make a perfectly water-resistant protective coating out of a material which consists largely of linseed oil. Substances brought forward as protective coatings which dry by evaporation of the solvent, seem to offer much more prospect of success.—*Dr. C. B. Dudley, before American Society for Testing Materials.*

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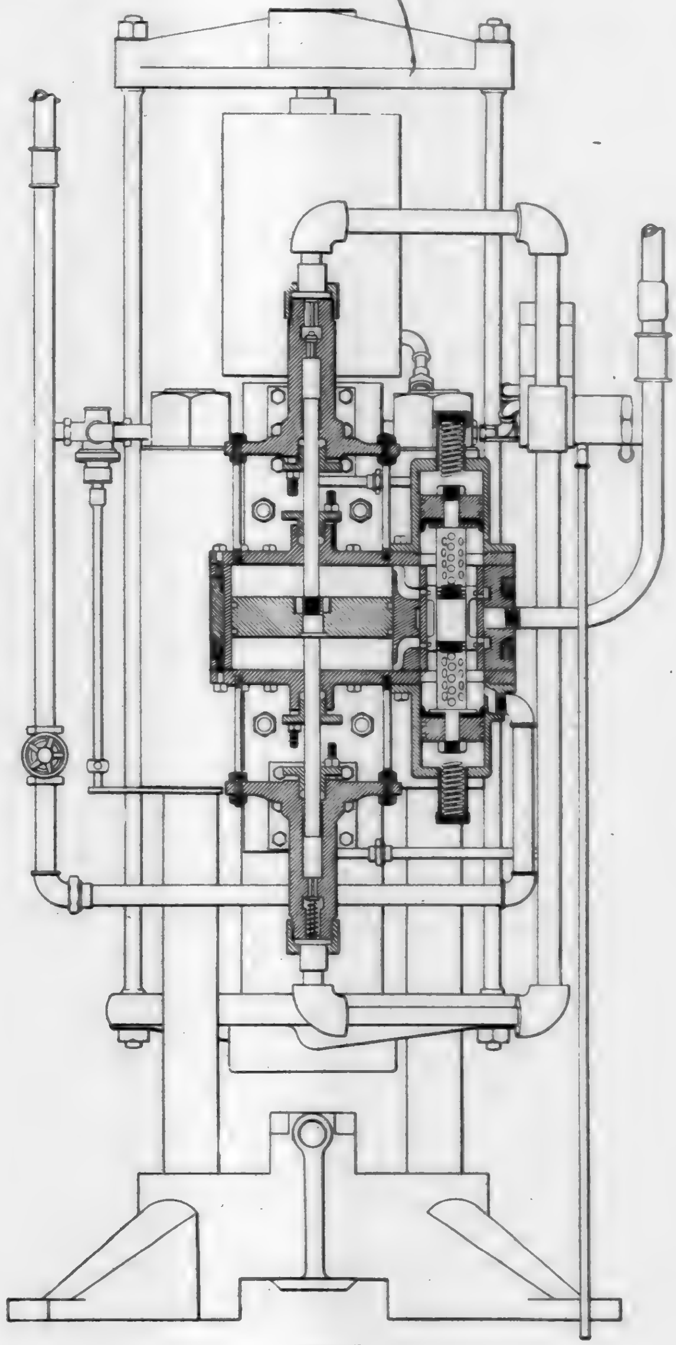

FIG. 3.

The Society of Engineers of Eastern New York met in Troy February 15. The paper of the evening was entitled "Modern Ordnance," by Captain O. D. Horney of the Ordnance Department, U. S. A., at Watervliet Arsenal. The total membership is now 175. The following officers were elected: Professor O. H. Landreth, president; Captain Odus C. Horney, vice-president; W. I. Slichter, treasurer; J. A. Kinhead, member Finance Committee; F. E. Crane, member Executive Committee; Albert E. Cluett, secretary.

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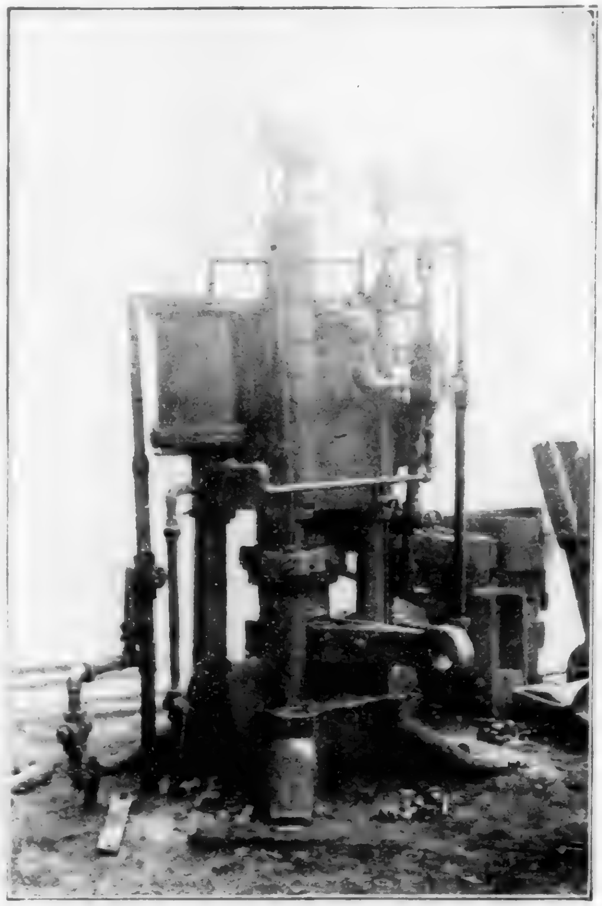

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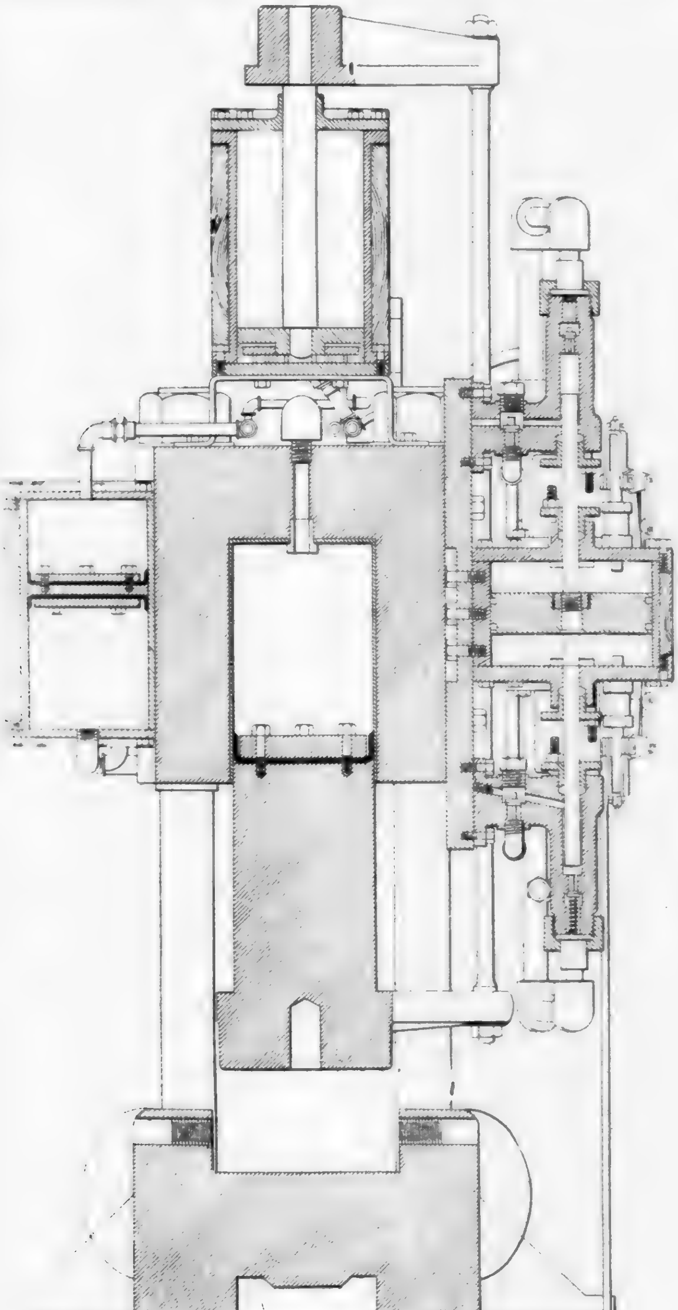

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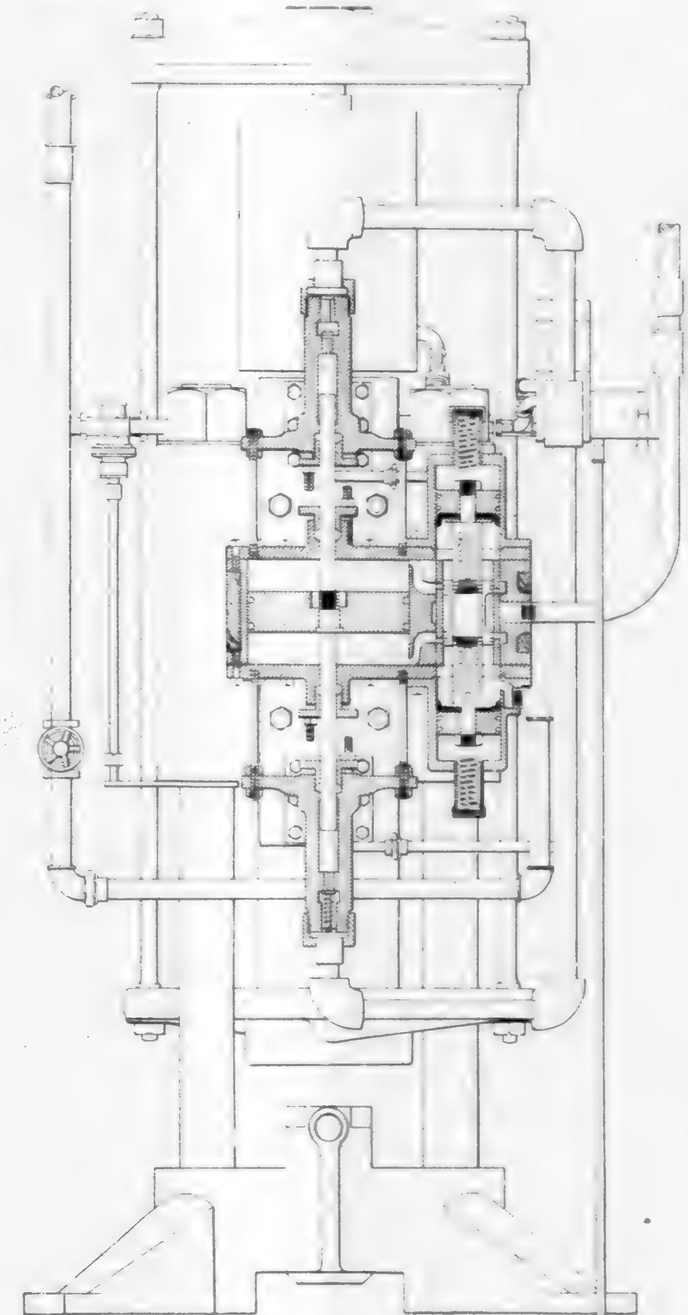

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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We cordially invite our many friends attenuing the conventions at Manhattan Beach in June to make use of our offices. Telegrams and mail addressed in our care will receive careful attention.

In this issue an account is given of the productive improvements at the Chicago shops of the Chicago & Northwestern Railway. This remarkable record from an old shop sets a difficult pace for the superintendents of the newer shops.

It is one thing to build a new shop plant with good buildings and cranes. It is another thing to supply the necessary machines and other equipment. Most of the recent shop plants are well supplied with buildings and tools, but the remaining requisite is an efficient organization and effective shop management.

ELECTRIC TRACTION.

In a valuable paper on developments in electric traction read by Mr. W. B. Potter before the New York Railroad Club, and which is partly reproduced on another page of this journal, some interesting figures are given concerning the comparative cost of operating railroads by steam and electricity. In the discussion Mr. W. J. Wilgus stated that the cost of electrifying the New York Central suburban service will be about one-quarter of the expenditure to secure the full value and benefit of electrification. He also called attention to the necessity of abolishing grade crossings. Mr. B. G. Lamme advocated the use of alternating current motors and higher motor voltages as the next logical step in improvement. Mr. Bion J. Arnold also advocated the alternating current system and stated that in his opinion our main steam railways will eventually be operated by electricity, first for passenger service and finally for freight service. The equipping of the suburban service with electricity will induce some road which has sufficient density of traffic to equip its passenger service electrically between trunk line points. Then the other roads will soon have to furnish electric passenger service between competing points, and after their passenger service becomes equipped, even though it cost more to operate by electricity, their entire service will eventually thus be operated, and the increased revenues due to different and speedier methods of handling freight will warrant the increased investment.

IMPROVED WATER SERVICE FOR LOCOMOTIVES.

There is no stronger contrast between modern and ancient practice in railroad operation than that shown in locomotive water service. Formerly delays at stations in order to fill locomotive tenders from very small water cranes, were taken as a matter of course and on many railroads such delays continue. If one operation connected with the handling of a train at a station stop is sluggish, other operations at that station are likely to be slow in sympathy. Many progressive railroads, particularly in the West, have appreciated the importance of suitable water service and have equipped main lines with large cranes with rapid delivery. The latest practice changes the taking of water from the slowest to the swiftest work done in a station stop and much can be gained through the influence of this upon other work which must be done at a station.

Within a year or two 151 stations on a number of roads have been equipped with new water service, which includes 14-in. pipe connections for supplying water from the tanks to the cranes, combined with 12-in. crane spouts for delivering the water to the tenders. From these cranes 8,000 gals. of water is delivered per minute, and this is quite impressive when considered in weight, which means about 33 tons of water delivered in 60 seconds. There is not the slightest difficulty in handling the water at this rate as far as the water fixtures are concerned. This enormous stream is easily started and stopped, but there has been some difficulty in getting the air out of the tanks to admit such a flood of water. Larger manholes in the tanks are recommended and it even seems advisable to use an opening 3 ft. in width, extending clear across the tank. This will not only provide ample room for the escaping air, but will give additional leeway of 2 or 3 ft. in the range of the water crane.

Doubtless these fixtures cost somewhat more than the small and inadequate ones, but this would seem to be an excellent investment in view of the possibilities of reducing the time of important trains at station stops, which must be made up when running and at great expense of fuel and physical strength of the firemen. A campaign in this direction of improvement has been carried on quietly in the West with most satisfactory results.

AUTOMATIC STOKERS FOR LOCOMOTIVES.

Those who know most about locomotive stokers believe that they save coal. Certainly they save manual labor, and if they will save no fuel whatever, the mere mechanical handling of the fuel places them before railroads in an exceedingly attractive and promising light. Experience thus far has been confined to but one type of stoker (AMERICAN ENGINEER, July, 1904, page 284), and it has demonstrated certain facts sufficiently definitely.

This stoker is an attachment to, and not a part of, the locomotive. It merely throws the coal into the firebox, but does not relieve the fireman from carrying the coal from the tender. It has been mounted upon wheels, to be easily put out of the way, and when in service it monopolizes the only access for the fireman to the fire. It has definitely shown the possibility of throwing and properly spreading 17,100 lbs. of coal per hour over an area larger than can ever be used in a firebox. It works all day and does not tire in either hot or cold weather. As Dr. Goss puts it—the automatic stoker for locomotives is an automatic shoveler. But it needs to be more than that in order to meet the present needs and expectations. It must transport the coal from the tender to the grate, and it must be arranged in such a way as to permit the fireman to closely watch the fire and give the occasional scoopful by hand, which is needed to provide for variations in the burning of the fire. A device which is merely an at-

tachment, with provision for stowing it out of the way when out of order, cannot fill the requirements demanded of the locomotive stoker. It must be installed as a permanent part of the locomotive, and so regarded. This stoker is now being re-designed, and it is to be hoped that these features will be included. If they are included, the device may be expected to become an important influence on locomotive operation and design.

Incidental advantages of the stoker are a relief from smoke, an increase in the life of the firebox because of keeping the firedoor closed, a more uniform steam pressure, and the possibility of successful use of inferior grades of coal. The chief advantage, however, lies in the large capacity for throwing coal.

Eventually, the stoker may influence the design of fireboxes. Mr. Henderson believes that fireboxes as long as 14 ft. may be successfully used, as the stoker easily covers even a greater length than that. He suggests the return to the 4—6—0 type for 6-coupled engines. This may or may not be done, but the matter of greatest importance just now is to get the stoker into shape to carry the coal from the tender to the fire, and do it in such a way as to permit of supplementing its automatic operation by manual skill, to provide for the conditions which cannot be met by means of a brainless machine. It is difficult to see how the device can be successful without these two essentials. With them the present stoker ought to be completely successful in the hands of intelligent men.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

PARIS.

The efficiency of locomotive engineers and firemen both in England and in France impressed me, and this led to as careful a study of conditions as time permitted. As a result I have a collection of information which may be suggestive to American managements, showing how these foreign roads bring engineers and firemen to view the coal pile on the tender as if they had paid for it and had it in their own cellars.

Coal premiums constitute the secret. These receive very careful attention from the highest officials. They add to the clerical service, but the returns must be beyond all proportion to the trouble and the cost. The enginemen are not believed to be more intelligent than ours, but these premiums bring them into partnership with the company in the coal pile and they use their wits to save coal. Locomotive engineers over here do not leave the starting valves of Vanclain compounds open throughout an entire run, as some of ours do, because they do not care.

A French engineer cannot afford to waste coal, neither can he afford to be late or to set out cars. There may be reasons why the French premium plan will not work well on American roads, but some of the schemes used in England may be applicable. I shall be glad to place these before the readers if they signify an interest in them.

Through the courtesy of one of the leading motive power officials in France I received a copy of the service circular relating to the premiums paid engineers and firemen. This has been translated and is commended to the attention of those who are concerned in the administration of our railroads. I was not asked to withhold the name of the road, but courtesy demands this. The circular is as follows:

PREMIUMS ON ECONOMY OF FUEL FOR ENGINEERS.

The quantity of fuel allowed for hauling a given number of cars is fixed according to the section of the system traveled and according to the season of the year, by tables given out by the general superintendent of motor power. These tables comprise different allowances for winter and summer service. Summer service covers a period of seven months, April to October. Winter service covers five months, November to March. The premium, set per 1,000 kilogrammes of fuel saved (termed co-efficient), is fixed by the general superintendent of motive power.

The allowance per engine, running light, is fixed at 5 kilogrammes for engines (specifying engine numbers), and at 7 kilogrammes for engines (specifiying numbers). This allowance shall be 8 kilogrammes per kilometre for engines with 6 driving wheels and 10 kilogrammes per kilometre for engines with 8 driving wheels. Above allowances include starting of fire and maintaining same while waiting.

Allowance of fuel for engines, type 1775 (giving number and train) are fixed as follows from January 23, 1903:

Nature of Service.	Limited Number of Loaded Cars.	Allowance per Mile.	Allowance per Loaded Car in Excess.
South Express, summer..	10	32.73 lbs.	1.062 lbs.
South Express, winter....	10	34.50 lbs.	1.238 lbs.

The coefficient is fixed to $1.60 per gross ton.

Allowance of fuel for engines, type 1901 of the Depot of Toulouse, are fixed as follows from August 1, 1903:

Nature of Service.	Limited Number of Loaded Cars.	Allowance per Mile.	Allowance per Loaded Car in Excess.
Passenger train, summer.	8	29.78 lbs.	1.77 lbs.
Passenger train, winter..	8	31.52 lbs.	1.95 lbs.

The coefficient is fixed at $1.60 per gross ton.

Further, there is allowed for reserve service from 17 to 20 kilogrammes for engines specified in the circular by numbers. Whenever a train requires two engines the allowance for each engineer is calculated on the supposition that each engine hauls one-half of the train. Whenever a train, not requiring two locomotives, is nevertheless drawn by two engines under steam, the second locomotive is considered as running light. Road engines doing switching at stations are allowed 15 kilogrammes of coal per kilometre of switching. Locomotives destined to switching stations, have allowances fixed by the general superintendent of motive power.

Whenever a passenger train is behind time from any cause, for which the engineer is not responsible, and he makes up time during the run, he is granted a special premium for each minute made up during the run. This premium is determined for each train by the general superintendent of motive power, without exceeding the one given in the following table:

Kind of trains.	Maximum premium per made-up minute.
Fast and express	0 fr. 30
Through and local	0 fr. 20
Mixed	0 fr. 10
Freight-carrying passengers	0 fr. 10

A notice stating, for each train, the value of premiums per made-up minute is sent to the crew.

PREMIUMS FOR ECONOMY IN LUBRICATION.—Allowances of lubricating material are also fixed in a supplement to the circular.

PREMIUMS FOR RUNS.—Engineers are given premiums for runs, independent of the premiums for economy. The premium is calculated on the following bases:

Engines (engines specified by numbers) ...	f. 0050 per kilom. up to 5,000 kilometres f. 0075 per kilom. above 5,000 kilometres
Engines (engines specified by numbers) ...	f. 0075 per kilom. up to 4,000 kilometres f. 0100 per kilom. above 4,000 kilometres
Engines (engines specified by numbers) (trains of all kinds)	f. 0075 per kilom. up to 3,500 kilometres f. 0100 per kilom. above 3,500 kilometres
Engines (engines specified by numbers) ...	f. 0125 per kilom. up to 2,500 kilometres f. 0200 per kilom. above 2,500 kilometres
Shifters...............	f. 020 per kilom. for any run whatever.

For engines doing shifting service one hour's shifting is counted as 6 kilometres.

FINES FOR EXCESS IN CONSUMPTION.—For consumption of fuel exceeding the stipulated allowance in the special tables a fine is imposed equal to the stated figure for premium of economy. All excess of grease consumption causes a fine of 0fr. 50c. per kilogramme. These fines are most rigorously enforced unless the engineer proves that the excess in consumption has been independent of his will.

FINES FOR IRREGULAR RUNS.—Special fines, according to the seriousness of the case, are imposed when it is proven that a delay of any kind is caused by unintelligent waste of fuel or grease. Apart from these circumstances a delay of one minute is not attributed to the fault of the engineer running a passenger train, mixed train or a freight train carrying passengers. An engineer arriving, through his own fault, more than a minute behind time, suffers a fine of 0fr. 50c. per minute behind time, counted from the stipulated limit on. A delay may be discounted not only upon the train's arrival at terminal point, but also at meeting points with other trains, as well as turnouts and junctions, and in that case the fines may accumulate. A delay of 10 minutes is tolerated with freight trains. If the engineer, through his fault, arrives more than ten minutes behind time he suffers a fine of 0fr. 23c. per minute's delay counting from the allowed limit on. A delay

may be discounted, not only upon the train's arrival at terminal point; but also at meeting points with other trains, as well as at turnouts and junctions, and in that case the fines may accumulate. Every accident to the engine, from whatever cause, delaying the train more than 15 minutes, involves retaining of the engineer's premiums to the following amounts:

10 francs if the engineer runs a passenger train.

8 francs if the engineer runs a mixed train.

6 francs if the engineer runs a freight train.

These deductions occur likewise each time engineers find themselves, either through incompetence, or damage to the locomotive, obliged to put off cars, to refuse to complete their load, to require help or to have their engine replaced.

Reserve Engineers and Engineers of Work Trains.—Reserve engineers and those running work trains receive for each day of active service an average premium equal to the average premium of engineers (of the same class to which they belong) running scheduled trains. However, this premium shall never exceed 75 francs per month.

Firemen.

Road firemen are entitled to a premium equal to one-half of the net premium earned by each engineer for whom they fired, in proportion to the number of kilometres made with each of them. Firemen around warehouses and stations receive for each day of active service an average premium equal to the average premium of engineers in their district; but this premium can never exceed 2 fr. 50c. per day. Reserve firemen receive for each day of active service an average premium equal to the average premium of the firemen of the group to which they belong. If, however, they do shifting work in stations, for which work allowances have been established, they receive a premium equal to one-half of the premium which would result from the application of these allowances to reserve engineers.

General Arrangements.

The accounting of premiums is made at the end of each month by means of sheets which are taken daily from the reports made out by the conductors and signed by the engineers for each train: In their report of runs. In their report of shifting.

In the accounting of hauled cars, all cars are reduced to loaded ones, fractions omitted. Every car of a passenger train is counted as a loaded car. In figuring freight trains two empty cars are counted as one loaded car.

Allowances for Grease.

The locomotives are classified according to their size and service, and allowances specified for each, varying from 0.071 lb. to 0.178 lb. per mile. Switching engines are also classified and allowances of from 0.089 to 0.124 lb. per mile provided. The latter figure is made specially to cover switching service in some coal mines. The premium for saving grease is fixed at 2¼ cents per lb. saved.

Note.—These premiums are most carefully provided for and consciously administered. They are also very effective.

G. M. B.

(To be continued.)

Valve Motion and Locomotive Failures.—The speaker is of the opinion that more engine failures, so far as relates to machinery, are caused to-day by improper distribution of steam than by anything else, and my faith is strengthened in this opinion through the fact that we have a locomotive on this road that has a different valve motion from the other engines. It is designed on the Corliss principle, a rocking valve. This engine has been out of the shops for about 13 months, and has made, to date, about 96,000 miles, and has not had an engine failure due to machinery since it has been out of the shops, and the mileage made to 1-16 in. wear of tire is a little better than twice as much as is made by other engines of the same class, as well as being in the same kind of service, the only exception being the valve motion. This is not only true of the tire, but it is true of the entire valve motion, including the pins that operate the valves. After 13 months of service the tool marks are not worn out on the eccentrics and links, rocker boxes, etc., and in looking for the cause of this we find that it is due to a more even distribution of steam. This appears to open up a grand opportunity for decreasing engine failures as well as reducing the cost of maintenance.—*Robert Quayle, before students of Ames College.*

CORRESPONDENCE.

WHAT CAN A FIREMAN SAVE.

To the Editor:

Referring to the article on page 53 of your February number, under the head of "What Can a Fireman Save?" we believe the lack of education among engineers, firemen and shop men, as well as other branches of railroad employes in their duties, is due largely to the poor service rendered, and do not believe the increase in severity of discipline will help matters at all, but only tend to make them a great deal worse.

It is hard to say just who the best men are until they have had a fair training in their line of duty so as to determine by development.

In asking men to do any line of work that requires some knowledge it has been fully demonstrated that something more than brute strength is required.

We do not believe that education has been an expensive luxury in the past, but has resulted in good service and a great saving for railroad companies.

T. E. Adams.

WATER SOFTENING.

To the Editor:

Permit me to offer the following criticism regarding the very carefully prepared "Instructions to Pump-men" which appeared on page 51 of your February number. This method of going about to define treatment belongs to the same category as would the furnishing of each engineer with a kit of watchmaker's tools, and written instructions for their use, and then requiring him to keep his watch accurate. The ordinary workman employed in pumping duty is no more qualified to carry out chemical tests than the average engineer is competent to take his watch to pieces and reassemble the parts. The most carefully written set of rules for guidance will prove as inadequate in one case as in the other. We expect too much from a pump-hand when we expect this of him; and not only so, but we make too great demands upon his time. To keep in proper order the set of instruments and the solutions requisite for these tests, and to make the tests with due attention to accuracy, demands more time than the workman has to spare from his routine duty. Nor is such attention on the part of the pumper necessary. It may be well to send daily samples to some central laboratory, in order that we may be sure that everything is going properly: just as we wire the correct time, at some fixed moment, to all stations on the line, in order to check the accuracy of the clocks and watches of the employes. But, when a clock or a watch shows itself in need of repair, we have it attended to by a qualified watchmaker instead of sending instructions to the station agent or other employe.

The periodical changes which characterize all water supplies are never of such a cataclysmic kind as cannot be provided for by properly qualified men; and any source of supply so small and so exposed as to be liable to sudden and violent change—as by the waste water from a chemical factory, a dye-works, or other pollution—is so acutely dangerous that it must be rejected as boiler supply at all cost. Since the crux of this difficulty lies in the lack of necessary skill on the part of the workman, it is of no particular importance whether the tests furnished him are of a satisfactory kind or not; just as, since the ordinary locomotive engineer is bound to spoil his watch if he begins tinkering with it, so it is immaterial whether you give him a good or a bad set of tools to do it with.

It may, however, be permitted, as a matter of interest, to make a few remarks on the value of the soap test in determining the hardness of water. This test is no longer in use in any laboratory where accurate work is done. It has as completely gone out of responsible use as has the flint and tinderbox. Just as these last did good work in their day, so we have kindly recollection of the Clark soap test. But, for reasons of its established inexactitude, and because we have discovered elegant and accurate modes of doing what it proposed to do, we are content to relegate it to a place of honor among the gods whom we have ceased to worship. The following quotations from statements by men who have an acknowledged right to express an opinion on chemical subjects will be read with respect:

Otto Hebner, F. I. C., etc. (*The Analyst*, 1883, 77).—Of all methods of which analysts are in the habit of availing themselves in judging of the quality and composition of drinking water, that for the estimation of the hardness, by means of soap solution, is by far the most imperfect. I sincerely hope that the alkalimetric estimation of both descriptions of hardness will speedily supersede

the use of the soap solution, which has no other recommendation than its comparative antiquity.

Alfred H. Allen, F. I. C., F. C. S., etc. (*Jour. Soc. Chem. Indust.*, 1888, 795).—I submit that the time has come when professional chemists should cease to report results obtained by the soap test, and should abandon it in favor of other methods which furnish the information required more accurately, and quite as speedily, as Clark's process.

David Howard, Prest. Soc. Chem. Indus., 1886 (*Jour. Soc. Chem. Indust.*, 1888, 802).—What Mr. Allen has said about the soap tests would agree with the experience of a good many of his audience. For my own part, I have given up that test in despair.

Professor Percy F. Frankland (Dict. of App. Chem., 1900, Vol. III., p, 984).—In the presence of magnesia salts the results [of the soap test] are always less accurate; and, unless great care is exercised, may become wide of the truth.

R. Meldrum, F. C. S., etc. (*Chem. News*, 1898, 294).—Soap solution is not a reliable standard for determining the amount of lime present in very weak lime water, as will be seen from the following: * * *

J. C. Thresh ("Examination of Water and Water Supplies." London: J. A. Churchill, 1904, 190).—The futility of attempting to determine the amount of carbonates and sulphates of calcium and magnesium by the soap test is exemplified by the following experimental results: * * *

Leffmann and Beam ("Examination of Water." London: Kegan, Paul, Trench & Co., 1891).—These authors, in describing methods of determining the hardness of water, make no mention whatever of the soap test.

Opinions of the character here illustrated might be multiplied indefinitely—but these may suffice. It is, of course, very much to be desired that tests sufficiently simple in execution to render them effective in the hands of ordinary laborers, and sufficiently delicate to ensure a high degree of accuracy, should be available. That these conditions are not fulfilled by the tests named need not surprise us, when we stop to think what 5 to 10 grains per gallon really means. Ten grains per (imperial) gallon is only one part in seven thousand. This is a higher degree of accuracy than was expected, or, indeed, attainable, in the average output of work from a well equipped laboratory. Expressed in percentage results, it means accuracy to within one unit, in the second place of decimals.

We are working (in water softening) upon immense volumes, but it does not follow that an extra shovelful or two of the reagent makes no difference, for our solution is a highly attenuated one, a fact which—if proper results are desired—must be kept constantly in mind. If one might be permitted to desecrate Browning's immortal lines by such an application of them, I would quote:

> "Oh, the little more, and how much it is;
> Oh, the little less, and what worlds away!"

A. McGill.

Editor's Note.—We regret that Mr. McGill's communication was received too late to refer to Mr. Campbell for reply in this issue. On another page of this journal Mr. Campbell presents some interesting data concerning the cost of treating the water and the remarkable results obtained by the method of chemical control outlined in his article. The concluding number of his article on "Water Softening" will present some data as to the accuracy and value of the soap test in the experience of the Pittsburgh & Lake Erie Railroad.

PACKING TROUBLES OF THE "S. M. P."

To the Editor:

"Are we having trouble with packings?" said the S. M. P. "Well, I should say we were, it is the worst thing on the road. Just look at this pile of papers on the desk." They were about one foot high. He said, "All of them are about steam leakages on the front of our engines, and of course every one says they are packing, why things are so bad that this correspondence is from every one from the president down to the train master. Why don't I go down in the shop and see where the trouble lies and go out on the road some? Well, how can I find time with such a batch of correspondence to answer, it will probably consume the entire day in this work, so that I have no time to go down into the shop or out on the road, except when particularly ordered to do so by the G. M. Why, this packing trouble is so bad that every time there is a train detention the engine men report packing trouble as the cause of it, and it is getting to be a more universal complaint than wind. Only the other day one of our men was running backwards and got into something and then stated that he could not see signals on account of steam leakages from the front of the engine. All the boys are getting on to it and are making it responsible for most of their mistakes.

"Did I see an article published some time ago in one of the engineering papers about packing troubles and the way to correct them? I did, but it was several months after the article appeared and then only because it was sent to me by one of our vice presidents, who happens to be connected with the financial end of our road, whose uncle previously owned reams of our stock, every once in a while he worries me by sending letters about articles in technical papers. The article he referred to was pretty good, but of course I did not have time to find out, as the answers of 'why is this thusly' correspondence takes up most of the time.

"I can spare a little time to talk to you about this trouble, while the chief clerk is looking up some of these references. Several years ago things got so bad that we had a packing expert live with us awhile, and it is really surprising how much good that fellow did, our engines were not only decently steam tight, but it would cost us a good deal less to maintain packings if they were handled as he did it, but he was not in our employ, so, of course, when he left, things, somehow or other, drifted back in the old condition. We had him instruct all the men he could get a hold of, but as they had a whole lot of other things to remember, and as packing did not tie up a road as badly as hot driving boxes and broken stay bolts, it was not kept up as he suggested.

"You say that our roundhouse men are not making proper repairs to packing? Well, it seems rather queer if this should be so, as the roundhouse foreman is an old engineman himself. That fellow used to run the general manager's engine, but of course when he got too old for that we had to find something for him to do, so we put him in charge of the roundhouse. It would never do to lay him off after such valuable service and how else could we use him? He may not keep the men up probably as well as a younger man would, but still he gets the engines out. You say that he does not require the machinists to apply proper size rings to packing and to see that the other parts of the packing are all right? We must stir him up on this point, and it may do some good. Then again you say we are not properly manufacturing our packing rings. We have given proper instructions on this point, and if they are carried out will produce good results, but of course it is as you say, there is an old lathe on this work, but then we could use the lathe on nothing else, it was too badly worn to do some of our particular work, so packing rings were about the only things left for it. We cannot scrap the lathe, for that would bring the whole establishment down on us, and then the tools that are used in the lathe were designed by one of our best foremen and we might lose him if we changed over to another system of ring manufacture, at least I would have to continually butt against him, and as he is foreman of that department I naturally depend upon him to see that the work is properly done, but you may be right in saying that at times it is fairly done and then again it is not!

"Why don't we buy the rings from some packing concern? To suggest that to the general manager would almost be like handing in my resignation. I would immediately have to explain, we could manufacture the rings cheaper per set than the manufacturer or show why, then by suggesting to purchase something which was costing us more than we could manufacture for ourselves. I would be putting myself in a poor light. Of course per engine mile we would be saving considerable money by purchasing them outside, made of proper metal and machined to fit, but it is hard to explain this to him, and we have to take care of enough figures nowadays to set a college professor crazy, without adding any more about packing. We have tried other designs of packing, in fact about everything on the market, and keep on trying them with about the usual result, that is, they show up finely on tests but when put into regular service give even worse results than our standard. Of course some packings are better than others and I think we are buying the best on the market, at least this is borne out by the fact that most other roads are using it and the whole trouble comes when the packing requires new rings, and then I will admit that things do get pretty bad.

"How to correct this trouble? Well, that is pretty easy to talk about, but it is entirely another matter to compel. The proper way would be to specialize it as we do our air brakes, and have trained men on it. These special men would of course cost money, then when it came time to reduce expenses these men would be pointed out as an unnecessary expense, and we would probably lose them and then things would drift back into their old conditions.

"I can't talk to you all day on this question as the chief clerk is about due again and I will say, that if you are earnest in try-

ing to get people to correct this kind of trouble it will either be necessary for the management to specialize packing and appoint a proper person to enforce proper use of it, or see that railway officials are not overloaded with work, so that they may attend to details of this nature as they should be attended to. By this I mean that we should have good live instruction and well paid men, as both shop and roundhouse foremen, so that the other mechanical officials shall have time enough to devote to matters of this kind."

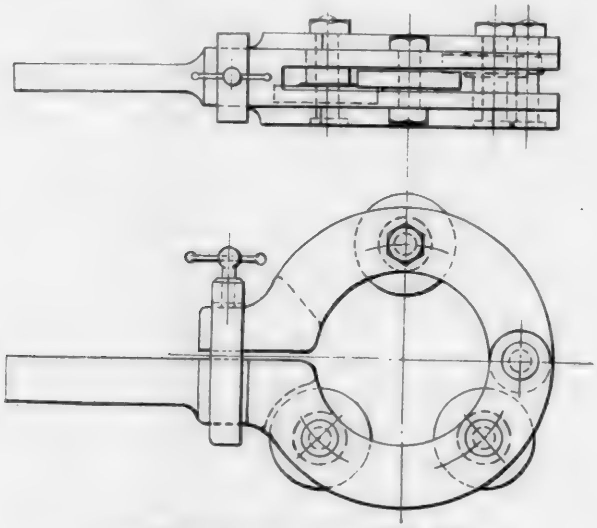
P. A. C. KING.

BURNISHING TOOL FOR PISTON RODS.

To the Editor:

I enclose a sketch of a tool devised at the Carbondale shops of the Delaware & Hudson Company. It has been customary when a new piston rod was wanted, to turn the material to the desired size and then file it smooth and finish it by polishing with emery and oil applied by means of a pair of wooden clamps. This process requires considerable time to obtain a good result.

A better scheme is to grind the rod, but such a process requires a grinding machine which all shops do not possess. With the tool shown, however, a regular finish cut is taken over the rod, the tool is then secured in the tool post and closed around the rod, the rolls being tightened by means of the screw clamp. A fine feed is then put on and with the proper lubricant the rod is rolled as smooth



BURNISHING TOOL FOR PISTON RODS.

as can be desired. The contrivance is not very costly, its construction being shown by the sketch. It need hardly be remarked that the rolls and the pins upon which they turn are to be made of tool steel and hardened. An advantage of this method is that by the rolling a hard compact skin is formed which makes a good wearing surface. There is also a great saving of time.

EDW. B. MCCABE.

[EDITOR'S NOTE.—This is a convenient burnishing tool, but the importance of installing grinding machinery should not be lost sight of where there is sufficient work of this kind to justify it. The subject of burnishers was referred to in this journal on page 337 of October, 1898, and on page 156 of May, 1899. Mr. L. Bartlett, of the Missouri Pacific, mentions the origin of the method by himself in 1891 on page 228 in July, 1899. On page 57, in February, 1900, the Pennsylvania burnisher was illustrated.]

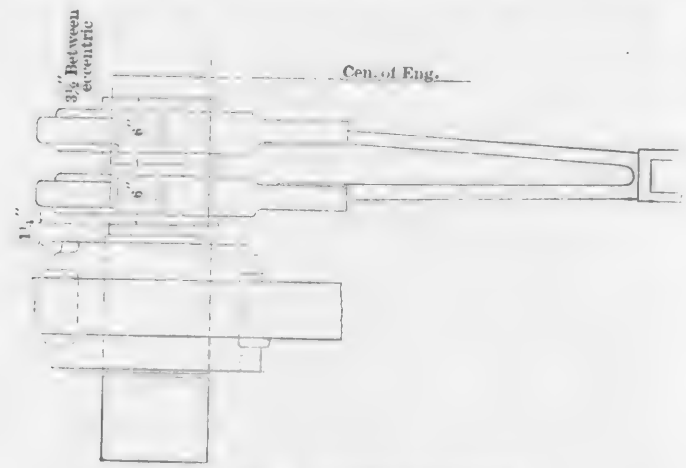
OIL FUEL IN BLACKSMITH SHOPS.—From my point of view, oil at 6 cents per gallon and coal at $5.00 per ton about balance, as far as the cost of the two fuels is concerned. The improvement in the quality of the iron produced by heating with oil is incalculable. An important factor in the operating expense is the power required for atomizing the oil and furnishing oxygen to produce perfect combustion. Compressed air I find to be an expensive commodity. Steam is also expensive, and from my experience is not as good as compressed air for the purpose. In my experience the old fan blast that is so well known in all forge shops is the cheapest and best when properly applied. From 8 to 10 ounces pressure is all that is required.—S. Uren, *before National Railroad Master Blacksmiths.*

WALSCHAERT VALVE GEAR FOR LOCOMOTIVES.

The new 2—8—0 locomotive of the Lake Shore & Michiga Southern Railway, fitted with Walschaert valve gear, wa illustrated on page 46 of the February number, and attentio was directed to the accessibility of the gear, its light weigh and the uniformity of the lead.

Of these features, that of accessibility is doubtless the mos important. The eccentrics of the Stephenson gear of a larg freight locomotive are now so large, and the room in whic to put them is so small, as to render them practically ina cessible, and they do not receive proper attention, either i the shop or on the road. As an example of crowding of e centrics, the accompanying engraving is presented, by courtes of the American Locomotive Company, which illustrates on of the worst cases found necessary in the design of a 2—8— type freight locomotive. With a long driving box and eccen trics 6 ins. wide, there is but 3½ ins. of space between th middle eccentrics on the axle. The rods take up vastly mor room than the eccentrics, and on examining a modern heav engine, it is not surprising that men dislike to crawl int such a mess on the road, in case of trouble, where pits ar not available.

Walschaert gear has been used for many years abroad, and



EXAMPLE OF CROWDED ECCENTRICS.

its development has been carried to a fine point in the deGlehn compound (see AMERICAN ENGINEER, June, 1904). In is application in this country it will be necessary to secure ample bearing surfaces and direct lines of pull and thrust, which are important in every valve gear. The weight is an element of extreme importance, because of the work which must be done at high speed in overcoming the inertia of ordinary gears weighing a ton and a half, with frequent reversals of direction. This is believed to have more effect in causing heating of eccentrics than the work which the gear is required to do in moving the valves.

In the case of the Lake Shore engine the men like the valve gear, and it appears to be in every way successful. The future of this gear in this country is not, however, dependent upon this particular engine. It will be surprising if the gear does not become a regular feature of American locomotive practice.

Machine shop profits of the present day are made up of time that used to be wasted by the old methods

LOW LABOR COST FOR CAST IRON WHEELS.—In a recent number the *Railway Age* described interesting equipment for a continuous process of casting car wheels, stating that the plant will produce 350 wheels in ten hours with 36 men, making a total labor cost of 24c. per wheel from mould to pit, inclusive. With the application of an additional improvement a further saving is expected, making the total cost for foundry labor 25c. per wheel, a reduction of 20c. per wheel from the old system.

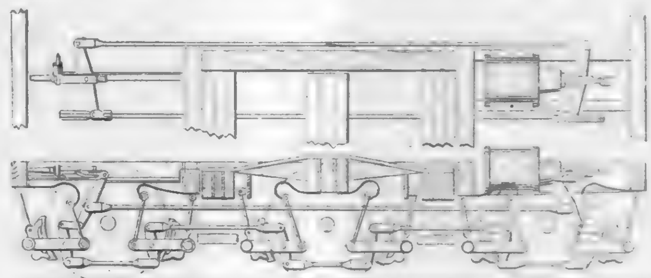
MILLER'S PARDON, OR THE TRIBULATIONS OF A ROUNDHOUSE FOREMAN.

William J. Miller ('course the name is fictitious),
Is a man who was never at all superstitious;
But a dream which he had is direct intimation
Of his faith in the doctrine of predestination.
Now, the said William Miller, please bear in your mind,
Is a bright roundhouse foreman, who, like all of his kind,
Has trials and troubles too many to state—
And with this introduction his dream I'll relate.
A spirit appeared at his bedside one night.
Decked out in a garment of pure, spotless white,
And thus addressed Bill: "To me has been given
Command from the Recording Angel in heaven
To ascertain why 'tis your name should appear
On the Great Book of Life, as the reason's not clear.
The profanity record has been kept for ages,
But nothing like yours appears on its pages;
Therefore, 'tis decided, unless you can show
Just cause for defense, to send you below,
Where the fire is unquenched, and those who have never
Repented, are roasted for ever and ever."
On hearing the latter, Bill tried hard to smile,
And invited the spirit to tarry awhile.
"If I fail to make my defense in full measure,"
He said, "I'll be sentenced with greatest of pleasure.
Please remain here to-morrow, accompany me,
And report to headquarters whatever you see."
The spirit agreed, I am happy to say,
And took note of what happened the following day.
First, a conceited young clerk, with expression satanic,
Brought a bundle of letters from the master mechanic.
And here a few extracts I'll give as example
Of the bunch that the spirit took away for a sample:
"Please note that the superintendent complains
You are using poor coal for our passenger trains."
"Please let me know what excuse you can make
Why so many new compound packing rings break."
"Engine failures, last year, for the month were but seven;
I regret for the same time this year there's eleven."
"You must take up the matter and ascertain why
We used so much oil in the month of July.
You are surely aware that a half pint to use
Of valve oil per hundred is simply abuse;
I believe 'twould be wise (at least we can try it)
To give engineers feathers with which to apply it."
"The president's special is leaving to-day,
At 10.25; there must be no delay."
But, alas! for the plans of mice and of men!
The telephone rang at a quarter of ten,
And the voice of the callboy announced with a drawl:
"De fireman is sick. Who else will I call?"
A fire-up man appeared just then at the door:
"The crown sheet is down in the 74."
Then next comes an engineer, swelled like a toad—
You'd think from his looks that he'd surely explode—
And asked loud in the name of the evil one:
"Why hain't the work on *my* engine been done?"
Bill Miller, he then made an angry retort;
While the spirit examined the work report
Of this same engineer, and this was the news:
"Wash out the biler and boar out the flews.
The seems are a squirtin'. Cork all the leaks.
The rite back driver box is so dry that it squeeks.
Steam pipes are leaking. Pack throttle well.
Right mane pin cut and runs hotter than —— (it should).
All the rod bushings are lose on both sides.
Set up the wedges and line up the gides.
The air pump jerks on the upward stroak.
Exzamin' and see if the valve ain't broak.
Take down left mane rod, reduce the brass.
And don't fail to put in a watter glass.
Raze the frunt end an inch or more.
And fix the ketch on the fire box door.
I think from the way she burns her fire
Her petticoat should be a little hire."
Before the good spirit got through taking notes
From the book containing the work reports,
From the chief dispatcher came a message which read:
"The Golden Gate Special's engine is dead.
Send another at once to take the train.
Why you sent this one on 21 please explain."
Then the hostler announced that a broken switch
Had caused him to put engine 12 in the ditch.
The spirit departed, but on that same night
Returned with a crown, and in greatest delight
Presented to "Bill's" most astonished vision
A text of the Recording Angel's decision,
And a list of the great hero saints all revealed,
With William J. Miller's name leading the field.

—*N. M. M. in Locomotive Firemen's Magazine.*

IMPROVEMENT IN BRAKING SIX-WHEEL TRUCKS.

In order to apply brake shoes to both sides of each wheel of a six-wheel truck, thus avoiding the tilting tendency produced by break beams on one side of the wheels only, and to equalize the brake rigging on trucks of this type, a new arrangement has been patented by the Westinghouse Air Brake Company, which contains a number of interesting features. Usually, trucks of this type have but three brake beams, and many of them have but two. The construction suggested in the accompanying engraving employs a brake cylinder supported upon the truck itself, the piston rod being connected to the cylinder lever, one end of which is connected to a vertical equalizing brake lever, while the other end connects to a pull rod extending to a corresponding lever at the other end of



SIX BRAKE BEAMS APPLIED TO SIX-WHEEL TRUCK.

the truck, the latter lever being fulcrumed on a slack adjuster. The brake beams have the usual hangers suspended from the truck frame, and they are arranged to carry the brake shoes on both sides of all the wheels. Brake beam levers are mounted on the brake beams with intermediate lower and upper rod connections. The equalizing brake lever at the right is connected at its lower end by a link with the first brake beam lever, while at an intermediate point it is connected by a pull rod with the vertical equalizing lever at the left. To support the stresses in the truck, struts are built into the frame, one of which is shown in the plan view. The engraving also shows the attachment for the hand brake at the cylinder. With this arrangement, the power will be equalized throughout the system, applying all the shoes to the wheels with equal pressure. This system is not known to have been applied to actual construction. It is presented as an exceedingly interesting development, meriting the attention of those concerned in the braking of present heavy equipment.

ELECTRICITY SUBSTITUTED FOR STEAM.—Mr. L. B. Stillwell stated before the International Engineering Congress the opinion that the application of electricity should not even be considered for steam roads on which the present traffic is not more than 10,000 ton-miles per mile of double track. The saving in cost of transportation by electricity over steam with a traffic density as low as this is more than offset by the charges on the increased capitalization.

YOUTHFUL INVENTORS.—Thirty days after the appearance of the first published accounts of Bell's invention of the telephone, two New York boys had built and were successfully operating an experimental telephone system of their own. These two boys have since achieved distinction in the electrical field, and have for many years been allied in business. They are Prof. Frank B. Crocker, of Columbia University, and Dr. Schuyler Skaats Wheeler.

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The following comparison of the direct current and single phase alternating current systems for electric traction is taken from a paper on "Developments in Electric Traction" by Mr. W. B. Potter, read before the January meeting of the New York Railroad Club. This comparison is especially valuable coming from the standpoint of one who represents successful practice on a large scale, and who has devoted so much time to study and practical work along these lines.

A great deal has been written concerning the possibilities of single-phase traction and, as is often the case with the development of a new principle, many appear to have formed too optimistic ideas of its capabilities. While we recognize the advantage of such a system in many cases, it is a mistake to imagine that it will be a cure for all ills and revolutionize the railway world. It is well, therefore, to have a clearer idea of the advantages and disadvantages of single-phase traction and also to analyze the reasons governing the choice of such a system. It is self-evident that the relative expenditure for equipment, operation and maintenance, should be the fundamental reason governing the selection of a system for any particular service.

The single-phase A. C. system possesses two features which recommend its use; economy of trolley copper, due to the higher trolley voltages, and the elimination of the rotary converter. The chief advantage gained by these features is a saving in the initial cost of equipment: factors which increase in importance in proportion to the amount of power required by each car or train and with the length of the trolley line. On the other hand, the A. C. car equipments cost more than the D. C. equipments for a similar service and the same given rise in temperature of the motors. It is, therefore, apparent that the relative cost of an A. C. or D. C. system will be materially affected by the number of cars employed.

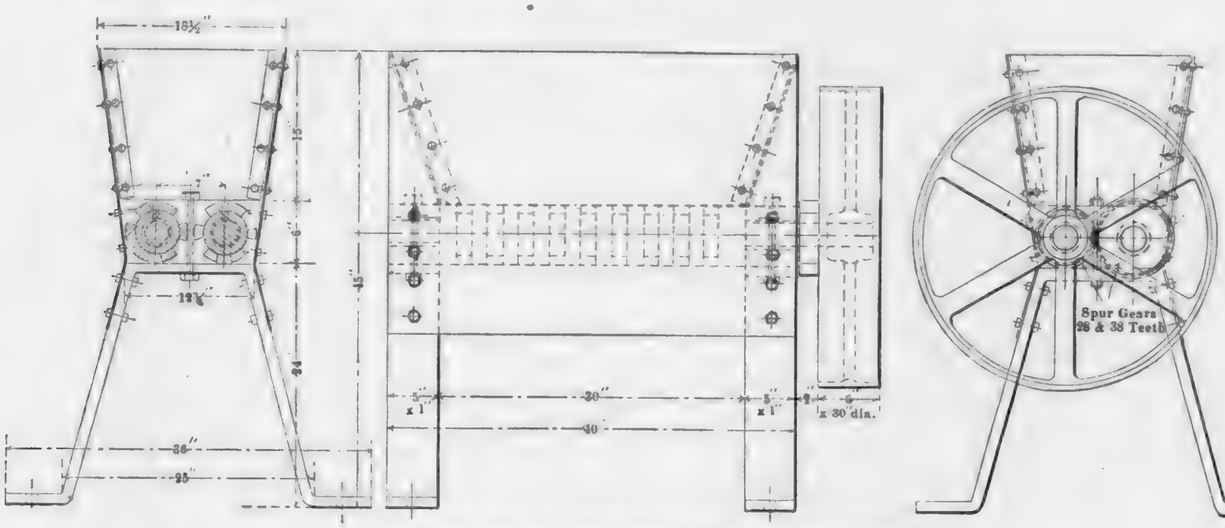
The saving in power resulting from the elimination of the rotaries is about off-set by the greater weight and slightly lower efficiency of the A. C. motor.

The efficiency of the A. C. control, during acceleration, will, generally speaking, be somewhat higher than that of the D. C. system with series parallel control. With the A. C. system fractional voltages can be obtained from the transformer on the car. Each step of the A. C. controller gives a running position which corresponds with the series and parallel positions in a D. C. controller.

The potential of the transmission lines from the power station may be selected, as in the case of the D. C. system, without reference to the trolley or secondary voltage. The trolley voltage must, however, be considered from a different basis than that of the D. C. system for the reason that in addition to the ohmic resistance of the trolley and track circuit, there is an apparent increase in resistance, due to the alternating current. This increase in apparent resistance for 25 cycle alternating current, as compared to direct current, is about 50 per cent. in the trolley wire and between six and seven times greater in the rail return. The rails being steel, the increase in apparent resistance is relatively much greater than in the trolley wire. As the resistance of the track return with large steel rails is proportionately much less than that of the trolley wire, the apparent increase in resistance for the latter and the track taken together will be, roughly, from one-half to twice that for direct current. An alternating current at 1,000 volts, is, therefore, about equivalent to 600 volts direct current so far as affecting the amount of trolley copper, and to secure the advantages of the A. C. system to a reasonable degree at least 3,000 volts or, for heavier service, perhaps 5,000 volts must be employed.

The design of an A. C. motor as regards length of air gap and armature speed is affected by the lower average flux density. For this reason an A. C. motor is larger and heavier than a D. C. unit of the same output. The commercial A. C. motor represents a compromise in which the armature speed is somewhat higher and the air gap slightly less than would be the case in a D. C. motor of corresponding capacity. I have mentioned these facts to indicate that the maintenance of an A. C. motor will, in all probability, be greater than that of an equivalent D. C. motor, due both to the higher armature speed and the smaller air gap.

The equipment of heavy locomotives with A. C. motors for high speed passenger service is a possibility, but owing to the limitations imposed by the space available, for the motors, it seems probable that two locomotives, each with four motors, would be required for service which could be performed by a single D. C. locomotive with four gearless motors. For locomotives in slow speed work, such as freight or shifting, a double gear reduction will, in many cases, be required, owing to the difficulty of winding an A. C. motor of large size for slow speeds.



COKE CRUSHER—PITTSBURGH & LAKE ERIE RAILROAD.

COKE CRUSHER

The drawing shows a simple but efficient coke crusher which can readily be made at a small cost and which running only part of the time will crush all the coke required in a large blacksmith shop. The rollers are made from old driving axles and are 6 ins. in diameter. Longitudinal grooves 1 in. deep are cut in one of the rollers, while the other one in addition to the longitudinal grooves has a series of circumferential ones, thus covering its surface with coarse teeth. The rollers have their bearings in cast iron blocks, which are bolted to the 5 x 1-in. wrought iron supports. The hopper is made of steel plates, fastened together at the corners by light angle bars. The driving shaft operates at a speed of 78 r.p.m. This machine was made and is in use at the McKees Rocks shops of the Pittsburg & Lake Erie Railroad. We are indebted for the drawing and information to Mr. W. P. Richardson, mechanical engineer.

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[FO]UR-CYLINDER VAUCLAIN BALANCED COMPOUND LOCOMOTIVE.

4—6—0 Type—'Frisco System.

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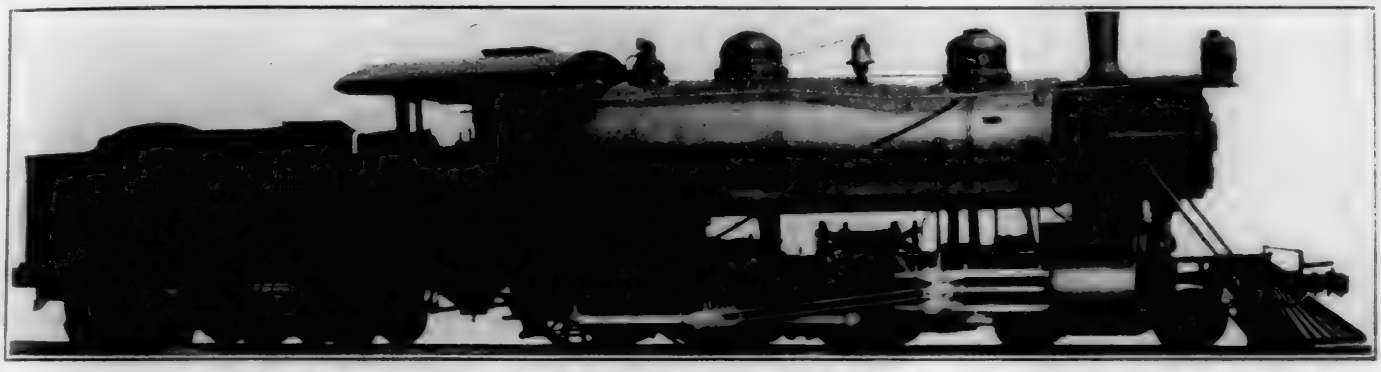

VAUCLAIN 4-CYLINDER COMPOUND LOCOMOTIVE—'FRISCO SYSTEM.

W. A. Nettleton, *General Superintendent of Motive Power.* Baldwin Locomotive Works, *Builders.*

4-Cylinder Vauclain Balanced Compound 'Frisco System.

Gauge	4 ft. 8½ ins.
Cylinder	15½ ins. and 26 ins. by 26 ins.
Valve	piston
Boiler—Type	wagon top
Diameter	64 ins.
Thickness of sheets	⅝ in., 11-16 in. and ¾ in.
Working pressure	225 lbs.
Fuel	soft coal
Staying	radial
Firebox—material	steel
Length	101⅞ ins.; width, 66 ins.
Depth	front, 70 ins.; back, 58¼ ins.
Thickness of sheets	sides, ⅜ in.; back, ⅜ in.; crown, 7-16 in.; tube, ½ in.
Water space	front, 4 ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—material	iron, wire gauge No. 11
Number	278; diameter, 2¼ ins.; length, 18 ft.
Heating surface—Firebox	160.7 sq. ft.
Tubes	2,933.7 sq. ft.
Total	3,094.4 sq. ft.
Grate area	46.69 sq. ft.
Driving wheels—diameter outside	62 ins.
Diameter of center	56 ins.
Journals	front, 10 ins. by 10¾ ins.; others, 9 ins. by 12 ins.
Engine truck wheels, front	diameter, 30 ins.
Journals	5½ ins. by 10 ins.
Wheel base—driving	13 ft. 6 ins.
Rigid	13 ft. 6 ins.
Total engine	27 ft. 7 ins.
Total engine and tender	55 ft. 8 ins.
Weight—on driving wheels	134,920 lbs.
On truck, front	49,840 lbs.
Total engine	184,760 lbs.
Total engine and tender (about)	302,000 lbs.
Tank—capacity	6,000 gallons
Tender—Wheels, No. 8	diameter, 33 ins.
Journals	5 ins. by 9 ins.

SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN RAILROAD SHOPS.

The following is taken from a very valuable article on the "Systematization and Tool-Room Practice in a Railway Repair Shop," by Mr. R. Emerson, which appeared in *The Engineering Magazine:*

System as applied to one small tool room is a paying investment in the tools saved, and in the facility with which the proper tools are available when wanted. System as applied to the tool regulation on the whole railroad pays, not only to this extent, but to an even larger degree in the standards it is possible to establish, and in the decreased cost of production due to manufacturing locomotive parts by these standard tools on large scale, and accurately, so that they will fit in distant roundhouses. For instance, in the locomotive repair shops the customary method has been to ream out the old frame-bolt hole with standard-taper reamer, but without any given diameter. The new method would call for a series of diameters of these taper-bolts varying by 1-32 in. An engine passing through the shops would have all her frame holes reamed out to the size next larger than the one previously used. This could be done with a standard shoulder reamer of high-speed steel, the resulting hole perfectly accommodating the bolts in stock. Such a stock of bolts on one of the large railroad systems in this country represented an investment of less than $1,200. Needless to say, the interest on this sum and on the somewhat more expensive tools was insignificant, compared to the greater expense of putting in bolts in the old individual way. It is the province of the tool man to care for these reamers, and to keep them to standard. In order to do this properly, a tool system is needed whereby it will be impossible for a man to have one of them in his possession long enough for him to wear it below standard size.

For the whole system the tool-room may standardize the manufacture and application, as noted above, of frame bolts, or of knuckle-joint pins, or staybolts. The methods in the case of the last two items were very similar. For the pins, standard "taper-shoulder" reamers were provided for each size or class of pin, the number of such classes being reduced to a minimum—in the case I have in mind, four. Each class or nominal size was provided in four diameters, verying by 1-16 in. All new work was reamed to the first and smallest diameter, and at each subsequent overhauling to the next larger diameter. The use of these shoulder-reamers and their distribution to every shop and roundhouse of any size on the railroad system made possible the manufacture of these pins by turret lathe methods, to standard diameters and in large quantities, and the distribution of these pins as stock to the points where they would be needed, thus saving entirely the expensive method of turning each pin separately as occasion required and time pressed. Staybolts also are made very accurately to standard diameters, varying by 1-16 in. and 1-32 in., and to various lengths, sample staybolts of each lot being accurately gauged for size by limit-thread gauges. Stock of these bolts is distributed in similar fashion to that of frame bolts and pins, accurate fitting of the staybolts being insured by the maintenance, by frequent inspection throughout all the shops, of standard size of staybolt taps. When this manufactured stock of staybolts is first furnished, a complete canvass of every staybolt tap on the road is made in person, by some one competent for the job. These taps are permitted to be used only while they are within 3-1000 of size, all others being scrapped.

Of course, one must have a man, one with large ideas, ex-

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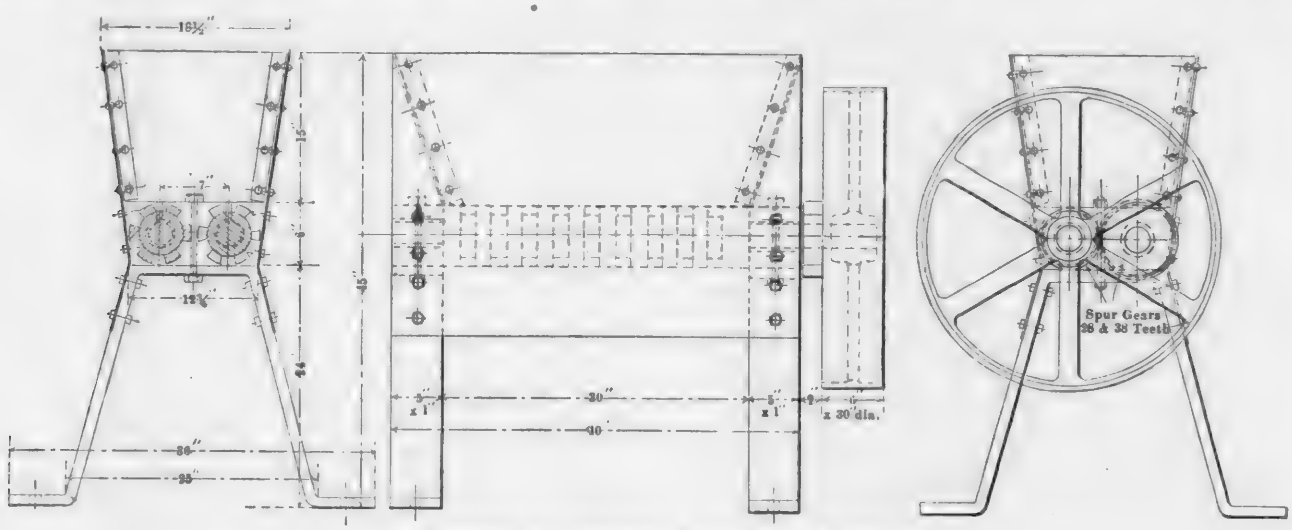

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Valve	piston
Boiler—Type	wagon top
Diameter	64 ins.
Thickness of sheets	⅝ in., 11-16 in. and ¾ in.
Working pressure	225 lbs.
Fuel	soft coal
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SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN RAILROAD SHOPS.

The following is taken from a very valuable article on the "Systematization and Tool-Room Practice in a Railway Repair Shop," by Mr. R. Emerson, which appeared in *The Engineering Magazine:*

System as applied to one small tool room is a paying investment in the tools saved, and in the facility with which the proper tools are available when wanted. System as applied to the tool regulation on the whole railroad pays, not only to this extent, but to an even larger degree in the standards it is possible to establish, and in the decreased cost of production due to manufacturing locomotive parts by these standard tools on large scale, and accurately, so that they will fit in distant roundhouses. For instance, in the locomotive repair shops the customary method has been to ream out the old frame-bolt hole with standard-taper reamer, but without any given diameter. The new method would call for a series of diameters of these taper-bolts varying by 1-32 in. An engine passing through the shops would have all her frame holes reamed out to the size next larger than the one previously used. This could be done with a standard shoulder reamer of high-speed steel, the resulting hole perfectly accommodating the bolts in stock. Such a stock of bolts on one of the large railroad systems in this country represented an investment of less than $1,200. Needless to say, the interest on this sum and on the somewhat more expensive tools was insignificant, compared to the greater expense of putting in bolts in the old individual way. It is the province of the tool man to care for these reamers, and to keep them to standard. In order to do this properly, a tool system is needed whereby it will be impossible for a man to have one of them in his possession long enough for him to wear it below standard size.

For the whole system the tool-room may standardize the manufacture and application, as noted above, of frame bolts, or of knuckle-joint pins, or staybolts. The methods in the case of the last two items were very similar. For the pins, standard "taper-shoulder" reamers were provided for each size or class of pin, the number of such classes being reduced to a minimum—in the case I have in mind, four. Each class or nominal size was provided in four diameters, verying by 1-16 in. All new work was reamed to the first and smallest diameter, and at each subsequent overhauling to the next larger diameter. The use of these shoulder-reamers and their distribution to every shop and roundhouse of any size on the railroad system made possible the manufacture of these pins by turret lathe methods, to standard diameters and in large quantities, and the distribution of these pins as stock to the points where they would be needed, thus saving entirely the expensive method of turning each pin separately as occasion required and time pressed. Staybolts also are made very accurately to standard diameters, varying by 1-16 in. and 1-32 in., and to various lengths, sample staybolts of each lot being accurately gauged for size by limit-thread gauges. Stock of these bolts is distributed in similar fashion to that of frame bolts and pins, accurate fitting of the staybolts being insured by the maintenance, by frequent inspection throughout all the shops, of standard size of staybolt taps. When this manufactured stock of staybolts is first furnished, a complete canvass of every staybolt tap on the road is made in person, by some one competent for the job. These taps are permitted to be used only while they are within 3-1000 of size, all others being scrapped.

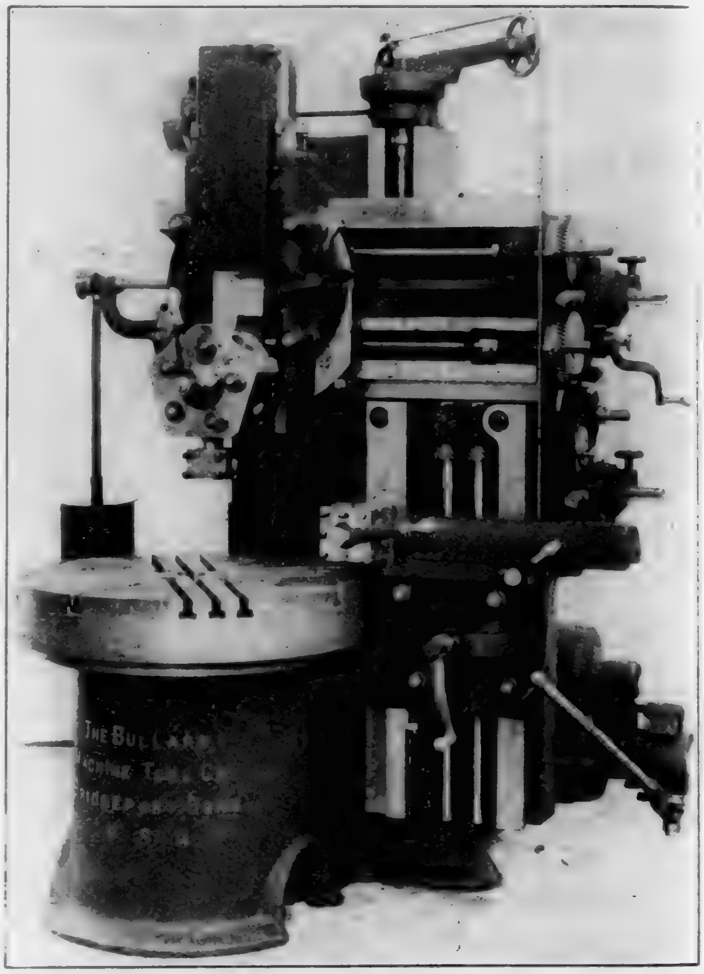
Of course, one must have a man, one with large ideas, ex-

perience and inventive fertility—presumably an expensive man—at the head of this tool system. He will see to it that the tool-room furnishes templets, jigs and tools for the rapid production on large scale of standard parts before it is forced to do so by the reiterated demands of some of the more progressive foremen; in other words, that the tool-room shall be leading the shop. The tool accounts on Western American railways vary from about $100,000 to $500,000 per year, and must reach over a million on such systems as the Pennsylvania. This sum sounds expensive for a mere incidental to locomotive maintenance; and it is expensive—extravagantly so—unless it is intelligently spent. Should this amount, however be doubled, three to four times the additional expenditur could be saved in cost of locomotive repairs. It can be authoritatively stated that when tool expenditures are well systematized, the efficiency of the system as a manufacturing output cheapener is not only manifolded, but the actual cos of operating the system itself can be materially reduced—from 12 per cent. to 20 per cent. in cases under my own observation.

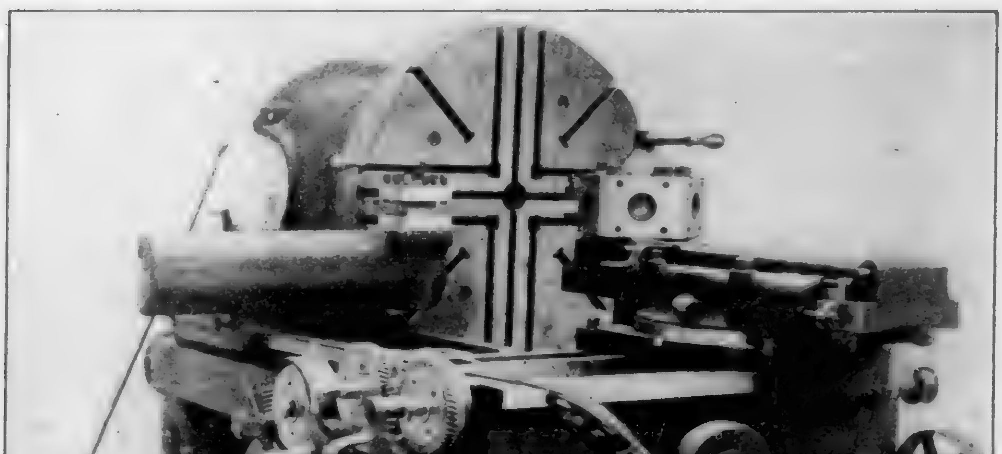
RAPID PRODUCTION VERTICAL TURRET LATHE.

For handling heavy face plate work the vertical mill illustrated in the photograph has several advantages over the horizontal lathe. The view of the mill lying on its side shows its close resemblance in that position to a horizontal turret lathe, and justifies calling it a vertical turret lathe. The advantages of the vertical type are that the work can be much more easily and quickly chucked, there is a freedom from vibration and chatter which is due largely to the heavy overhanging parts of the horizontal type, the frame or bed can be made more rigid, large spindle sizes and greater power are possible; the weight of the table, spindle and work rests directly on the large angular spindle thrust bearing and tends to preserve the alignment rather than destroy it; the side head does not make necessary the use of long boring bars and extended tool holders in the vertical turret, both heads may be operated jointly on work of small diameter without interference.

The vertical head will face 36 ins., has a vertical and angular movement of 26 ins., and may be set to an angle of 45 deg. either side of the center. The turret has five sides with holes for 2½-in. tools and has tapped holes for attaching special tool holders. The side head is equipped with a four-faced turret tool holder, has vertical and horizontal feeds and may be swiveled for angular facing up to 40 deg. either side of the horizontal. It has a vertical movement of 28 ins. and a horizontal and angular movement of 15 ins. The heads are operated independently and in no way interfere with each other. The feeds have safety points so arranged that carelessly permitting the heads to run together causes no damage or delay. This device does not weaken the feeds. Eight feeds, independent for each head, are provided and changes to any one of these may be made instantly by turning the star wheel to the proper point on the index plate. Change from vertical feed to cross feed or *vice versa* may be made instantly by engaging a centrally located drop worm with worm gears on the end of the feed rods. Pull gears are thus eliminated.



RAPID PRODUCTION VERTICAL TURRET LATHE—BULLARD MACHINE TOOL COMPANY.



VIEW OF VERTICAL TURRET LATHE, SHOWING ITS RESEMBLANCE TO HORIZONTAL TURRET LATHE.

By means of a speed box containing self-adjusting and powerful friction clutches, which are operated by a lever at the front of the tool, 15 table speeds may be obtained in geometrical progression. The table may be stopped instantly at any desired point by means of a brake without stopping the driving pulley. The table is 34 ins. in diameter, and is driven by an internal spur gear of large diameter. The cross and side rails have a vertical adjustment of 12 ins. by power.

All gears are encased and well lubricated. If desired the machine may be driven by a 7½-h.p. constant speed motor mounted on a bracket at the side or rear of the machine. The net weight of this machine, which is made by the Bullard Machine Tool Company of Bridgeport, Conn., is 9,000 lbs.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

EDITORIAL CORRESPONDENCE.

Grease lubrication for locomotives is increasing in favor. [No] adverse comments were heard. Where the Elvin driving [an]d truck box grease lubricator has been applied hot boxes [se]em to have been greatly reduced in frequency. To say that [ho]t driving boxes have become ancient history is asking too [m]uch credulity, but there is no doubt that this system of [lu]brication is a boon to the railroads.

One road had lots of trouble when grease was first applied [t]o driving journals. Grease lubricators were put into a lot [of] new engines and they cut the journals and heated in a dis[tr]essing manner. In this case it was discovered that the bear[i]ngs, which were of bronze, were extremely hard. When re[p]laced by softer brass the journals gave no trouble. Evidently Mr. Elvin's grease is particular as to the metal with which it associates. It must not have a "hard character."

Journals and bearings will undoubtedly wear more rapidly with grease than with oil lubrication, but if grease saves the cutting and scoring of journals due to heating, it is probable that the amount of journal material saved by avoiding frequent turnings of journals will more than compensate for the increased wear.

The lubrication problem is revealed in a new form by the locomotive superheaters. Important as they are in simple and compound locomotives, lubrication questions become vital ones in connection with superheated steam. Doubtless ordinary locomotives with the older types of lubricators depend in a large degree upon the water of condensation for their cylinder and valve lubrication. It is known that when a cylinder and valve are really lubricated with oil, the reverse lever will run a couple of notches higher than when the oil gets down slowly. The water of condensation, if it does not lubricate, at least carries off some of the heat, and as long as the engine will run the matter of oil lubrication does not compel the attention it deserves. Superheaters, however, are different. They will not run at all without excellent lubrication and here is where the superheater does a service to the ordinary locomotive. In the matter of piston rod and valve stem packing it will do a similar service. It is strange that lubrication and packing should depend upon the introduction of a new system which will not run at all with ordinary precautions in order to be made right. Every locomotive needs oil in its valves and cylinders from the very first stroke in starting. This requires a positive pump effect in the lubricator. The "big locomotive" needs all the help it can have from the best possible lubrication. Motive power people are quite ready to talk on this subject. They realize that it merits more attention.

Not so long ago hands came up in holy horror when increased driving wheel loads were suggested. That was before the days of 80-in. wheels. Now weights of over 20,000 lbs. per wheel excite little interest, although but few roads have been bold in this advance. The Pennsylvania uses weights as great as 29,500 lbs. per wheel, the Burlington 25,000 lbs. and the Lake Shore comes out with its new 2—6—2 type passenger locomotive with 29,000 lbs. per main wheel. The Burlington engine is balanced while the others are not, and yet there is believed to be no danger to the track. Of course, bridges are heavier and track better than formerly. These improvements are gradual and all roads are not alike in providing them. Inasmuch as increased wheel loads constitute the best possible traction increaser it is to be hoped that progress will be more rapid in this direction. The 4-cylinder balanced compound is an effective influence in this direction. Its possibilities are far from being exhausted.

Roundhouses should be equipped with more labor-saving appliances. There can be no possible question of the absolute necessity for cranes in roundhouses. Locomotive parts are becoming too heavy to be handled by hand labor, and in the absence of suitable facilities, absolutely necessary work which should be done in the roundhouse is left for the general overhauling in the shops, and engine failures as well as costly repairs are the result. We know how roundhouses can be built so that cranes may be used and yet progress in this direction is very slow. It would pay the railroads to equip their roundhouses to deal entirely with light repairs and thus keep many locomotives out of the shops. An ounce of repairs in the roundhouse is worth a ton in the shops. Every important roundhouse should be fitted up to expeditiously handle running repairs in order to reduce engine failures and increase locomotive mileage between shoppings. Opinions as to the roundhouse are undergoing radical changes, and the present tendency is to consider their repair functions as paramount. It is significant that a roundhouse illustrated about three years ago in this journal as being an excellent example of up to date practice is now considered obsolete and none of its fine points are considered applicable to a new roundhouse just put into service on the same road. It is also apparent that railroads are beginning to learn that locomotive operation, including roundhouse management, requires a very superior superintending ability.

Superheating as applied to locomotives is attracting the attention of railroad men in a remarkable way. So also are the four-cylinder balanced compound principle, the automatic stoker, and, in fact, every other principle which seems at all likely to contribute in any way to the economy of the operation of locomotives. Railroad men have never been blind to possible economies, but they are now interested in them for a new reason, which may as well be plainly stated. It is the limitation of firing. This presents a reason which never existed before for the improvement of the locomotive. No one in this country would have seriously considered such an improvement as superheating from the standpoint of locomotive efficiencies alone, but when it presents the possibility of enabling the fireman to shovel more horse-power into the firebox, it is looked upon with favorable interest. One American road, the Canadian Pacific, already has over forty locomotives equipped with superheaters; the New York Central has one, and several other roads are about to try them. The superheater, which came to us from Germany, has been improved and adapted to our conditions, and is about to be improved still further, so that superheating may be carried to a point limited only by such questions as are imposed by lubrication and packing. Of all the possibilities in the direction of increasing the efficiency of locomotives at the present time, this one appears to be most promising. It is a development which should be most carefully watched by all. If it should bring some new troubles it will also bring new blessings, and those who are facing the problem of supplying additional capacity for sustaining high power in locomotives should not await the results of the experiments of their neighbors, but should undertake experiments themselves. This applies to other devices besides superheating, and no railroad desiring to be progressive can afford to wait a day in unnecessary delay at this critical time of "engine failures."

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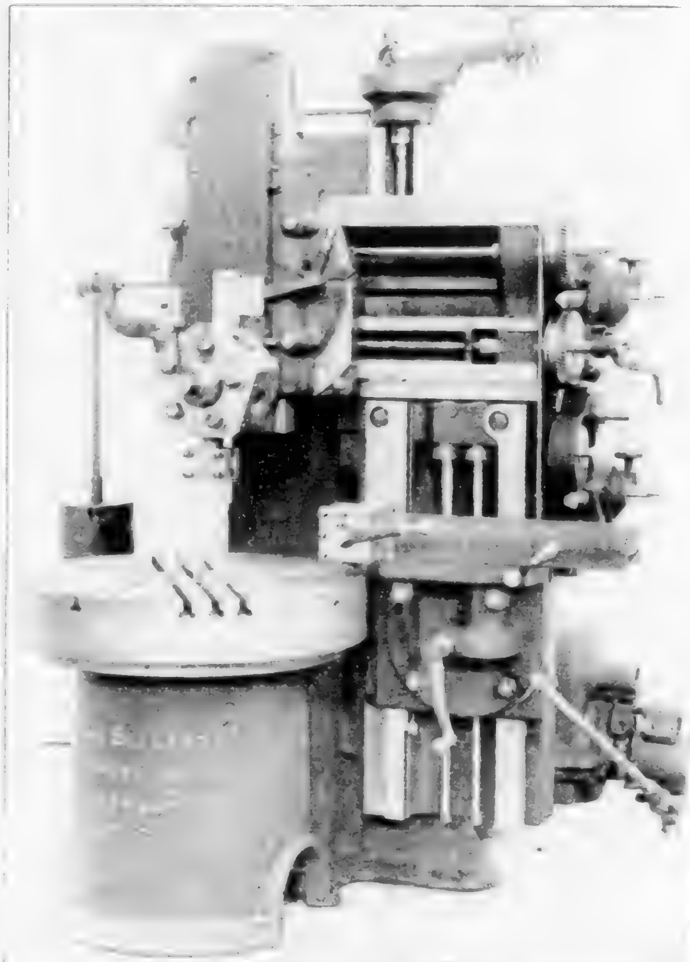

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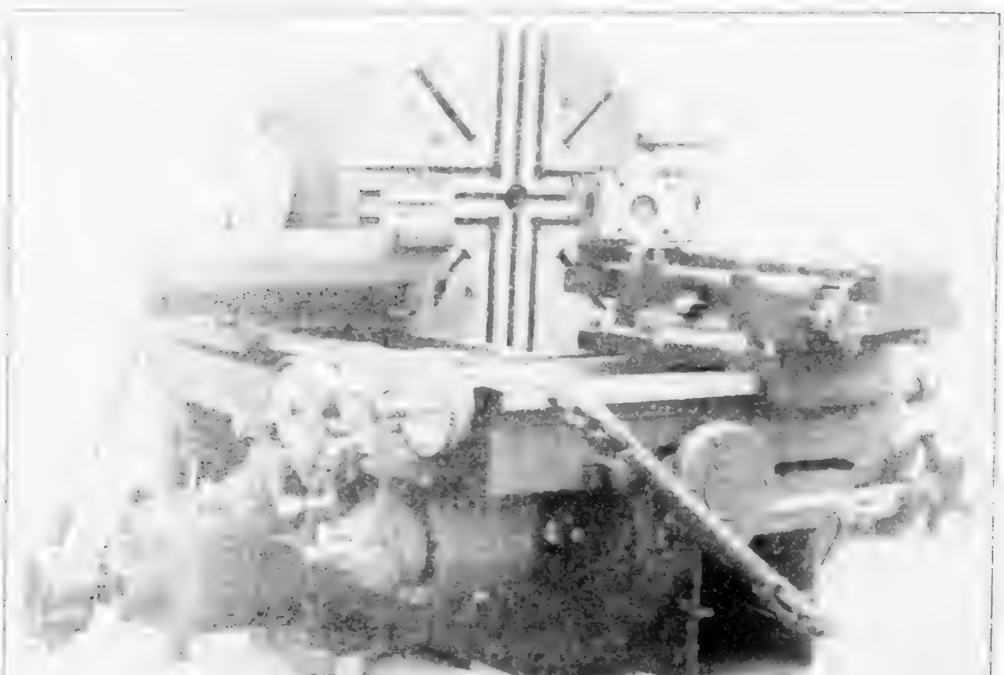

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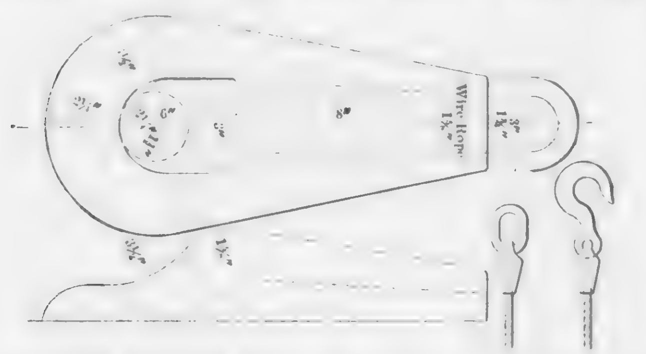
A SOCKET FOR CRANE SLINGS FOR LIFTING LOCOMOTIVES.

In response to an inquiry for a rule for designing sockets for crane slings for lifting heavy locomotives the accompanying sketch has been secured, which illustrates a socket made for use in connection with a flexible steel cable. The usual way for fastening the cable is to splice an eye in the end, forming a loop on a thimble enclosing a link or hook. The sketch illustrates a wrought iron cone socket into which the cable is leaded. It forms a simple and secure method of fastening and is in use in the locomotive erecting shops of the Delaware, Lackawanna & Western Railroad at Scranton, Pa. The dimensions are intended to be liberal and the construction is the same as that employed on the Brooklyn and the Niagara Falls suspension bridges, although the proportion of the sockets are not the same. This socket has more liberal dimensions than those on the market, which is believed to be



SOCKET FOR CRANE SLINGS FOR LIFTING LOCOMOTIVES.

good practice, considering the danger of injury to many men which the fall of the locomotive would cause.

A cable ordinarily 1⅝ in. in diameter is used and the sockets provide for a link at one end of the sling and a hook at the other. With a double crane hook two links are provided. Of course this sling is used for the front end of the locomotive only. In leading in these sockets, after being threaded through the small ends of the cones the wires were frayed out and many of the ends of single wires were bent over into the shape of hooks so that when the melted lead was poured in it ran around each separate wire and formed a solid cone shaped bulb on the ends of the sling. In order to guard against the possibility of the cable drawing through, a small quantity of antimony is used to harden the lead. The sockets are made of wrought iron.

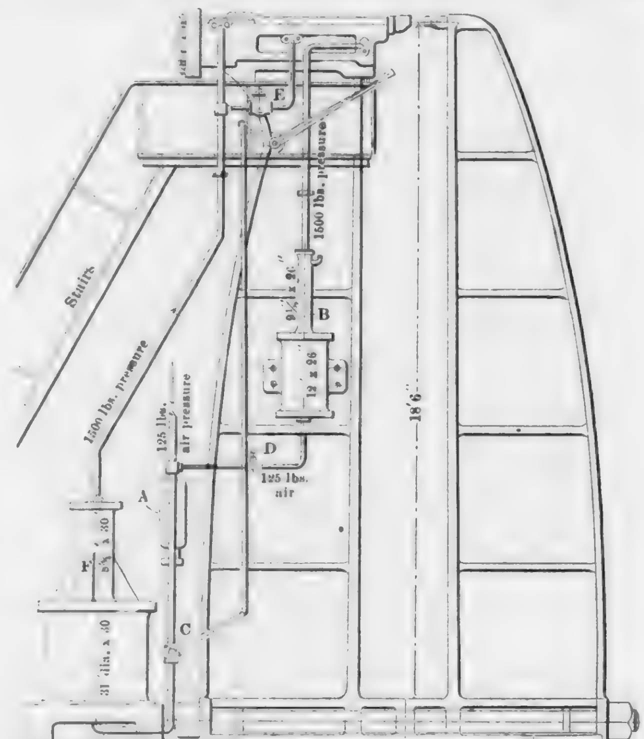
Young Men's Christian Association Results of the Year.—Mr. E. M. Willis, secretary of the railroad department of the International Committee of Young Men's Christian Associations has transmitted a new railroad department pamphlet entitled "Results of the Year," which describes graphically and concisely the remarkable development of the association work among railroad men during the year 1904. New buildings have been occupied at 16 different points; four buildings have been enlarged to accommodate the growing membership and 29 different railroad companies have co-operated in contributing the fund of $306,300 expended on these 20 buildings. Eleven of the 16 buildings are for new associations and associations have been organized at five other points during the year. The educational work has shown a gain of over 40 per cent. in twelve months. New members to the number of 9,800 have been added, making a total membership for 208 associations of 72,148. The total average daily attendance at these buildings was 37,419 during the year. The heartiest support and co-operation is credited to the men themselves and it is hoped that the railroads will do their part in meeting the needs of their employees. New buildings are practically assured at 16 additional points. The pamphlet illustrates a large number of buildings in all parts of the country, and the magnitude of the work is indicated, which cannot fail to make it a very powerful influence among railroad men. The pamphlet closes with the following quotation from the Hon. Paul Morton: "The Railroad Young Men's Christian Association is good for the men, better for the company, but best of all for the public."

HYDRAULIC RIVETER OPERATED BY A NEW SYSTEM

This riveter has an 18 ft. 6 in. gap, a riveting capacity up to 150 tons and a plate closing capacity of 30 tons. Under the new system by which it is operated no hydraulic pumps or accumulators are required and costly hydraulic valves and high pressure water mains are done away with. The hydraulic pressure of 1,500 lbs. per sq. in. is uniform and the machine is free from shocks caused by the dropping of the accumulator when the pump and accumulator system is used.

The arrangement for operating the machine is clearly shown in the drawing. By means of the lever which controls the three-way valve C, air at 125 lbs. pressure per sq. in. is admitted to what is known as the large differential. This consists of the small 8¾ by 30 in. water cylinder F, and the large 31-in. air cylinder. The ram which compresses the water in the upper part of the smaller cylinder is connected to the same rod as the piston in the air cylinder.

As compressed air is used in practically all boiler and bridge shops, hydraulic machinery operated by this system can readily be added to the equipment without installing an expensive hydraulic system. A substantial saving in the cost of



HYDRAULIC RIVETER OPERATED BY A NEW SYSTEM.

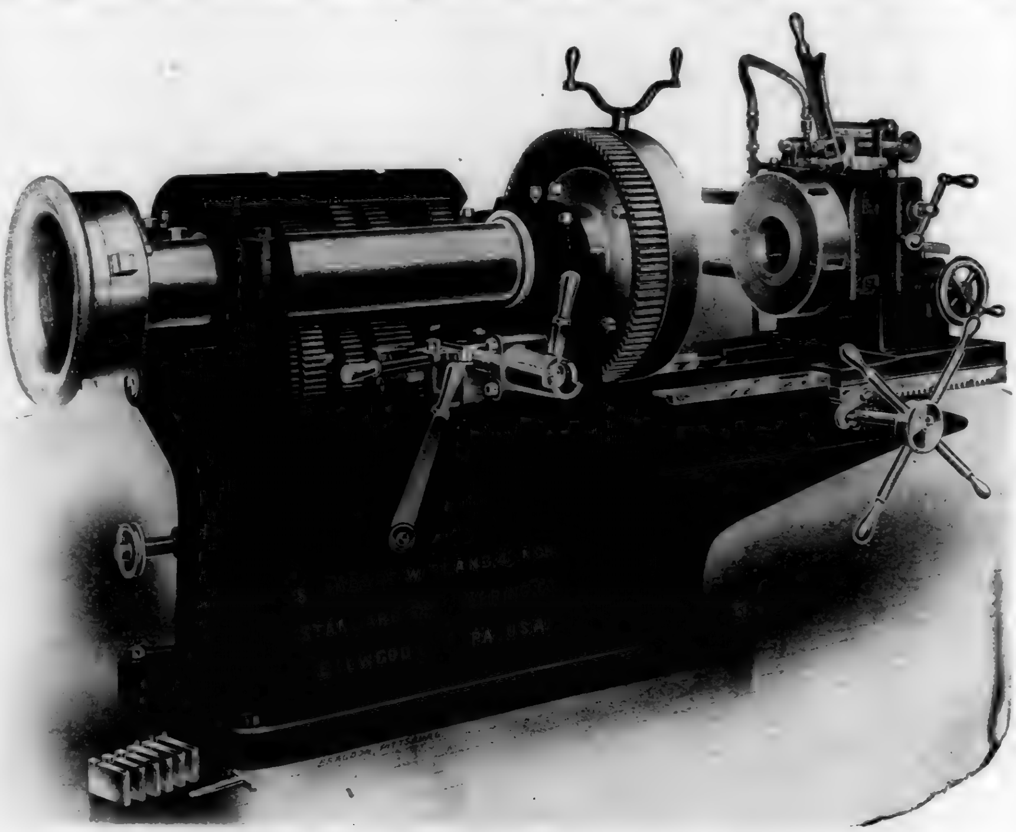
operation is also claimed. The pressure from the larger differential operates both the riveter and the plate closer, the plate closer automatically working in advance of the riveter. By means of the three-way valve E the plate closer can be cut out when not required. The small differential B furnishes pressure to push back the riveter and plate closer. Air pressure acts on this differential at all times but if necessary can be cut off by means of the valve D.

This system which is being patented by Mr. Wm. H. Wood, Hydraulic Engineer, Media, Pa., has been in use for some time operating several machines with excellent results.

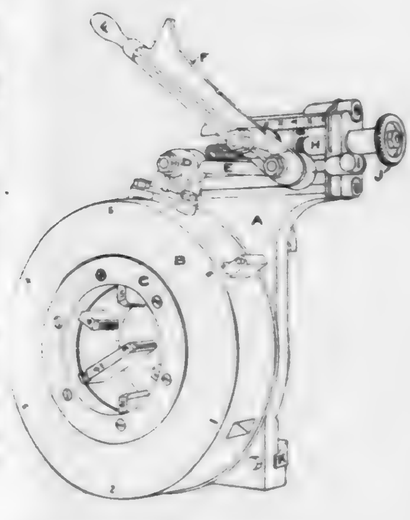
The Cost of Gas vs. Steam Power. Comparisons between operating costs of gas and steam power stations are not often made on a fair basis, but the *Engineering Review* records a comparison of two stations on the same system, operated by the same company, and so situated that the cost of fuel of both is exactly alike. The stations are in Guernsey, one at St. Peterport and the other at St. Sampsons. For the month of October the cost per unit generated was 69.2c. for the gas driven and 103c. for the steam driven plant.

PIPE THREADING AND CUTTING MACHINE.

he 4-in. pipe-threading and cutting machine shown in the ograph is of recent design and embodies a number of im- ant improvements. The construction is substantial, its ation is accurate and powerful and changes in speed or ad- ment may be quickly and easily made. The bed is cast in piece. Six spindle speeds obtained by machine cut steel ting gears are available. The speed changes may be made while the machine is in motion by means of levers conveniently placed for the operator.



STANDARD WIELAND 4-IN. PIPE THREADING AND CUTTING MACHINE.



WIELAND DIE MECHANISM

DIE OPERATING MECHANISM.

The die operating mechanism is a straight line lever device and as it has no connection with the adjusting screw is not liable to become loose. The adjusting screw H passes through a fulcrum nut or block G. The latter is provided with a clamp gib to make the adjustment positive. Moving the fulcrum block G to the left by means of hand wheel J, which is keyed to adjusting screw H, contracts the chasers radially. The lever F has an arc-shaped fin which rides on its rest and automatically centers the lever and connecting link E in a straight ine at all points of adjustment. Grooves cannot be gouged across the threads with this mechanism, as the chasers are withdrawn from the pipe the moment the lever is raised. The am ring B has an opening opposite each chaser which allows he passageway to be cleaned without removing the ring. The lower chasers, 1, 2 and 3, have a groove and are put into lace from the inside of the die-head. The upper chasers, 4, and 6, have projecting pins and are inserted from the outside hrough holes in the periphery of the cam ring. None of the hasers can drop out of place, and no stop is required on the am ring. The chasers are unusually deep, and if proper attention s given to keep them sharp, will cut a full thread on any kind f pipe at one cut. Those for 4-in. pipe will, when new, cut a erfect thread or screw end 2 ins. long. This is of advantage n several ways: It enables the cutting of a full taper thread for heavy fittings tapped deeper than standard—the Briggs' standard 4-in. threau being only 1.05 inches long; and it also allows the entrance of the chasers to be ground when necessary and still leave enough depth for a standard thread. The face ring C, through which screws pass to bear it against the front of the chasers, has an interlocking ring fitting into a recess in the bore of the die-head to prevent fine chips from passing through. The die head A may be slid aside before cutting off the pipe or removing it from the machine, thereby preventing the ruining of the bottom chasers by dragging the pipe across them.

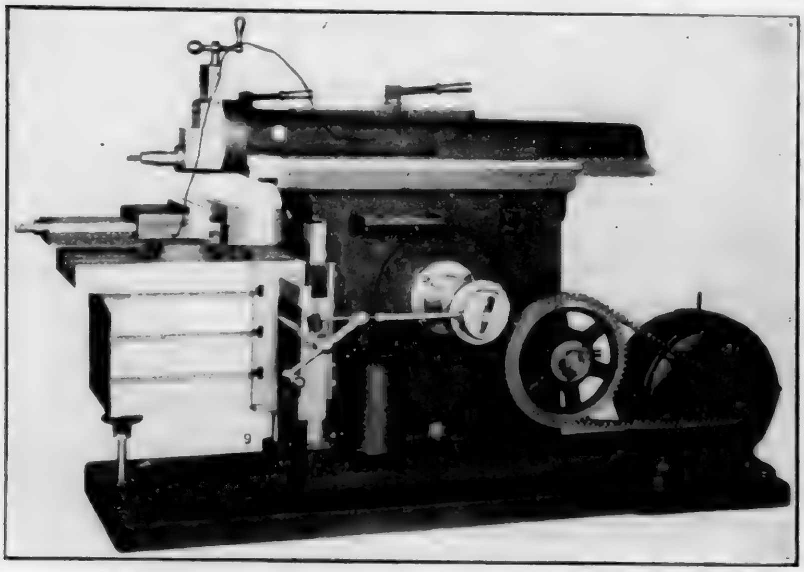
The cutting-off slide is fitted with a lathe tool post; the burr can thus be cut out of the pipe by turning the tool at an angle after the pipe is cut off. The gripping chuck at the front of the spindle is universal; the scroll chuck at the rear is used only for centering the pipe. A rotary pump delivers oil to both the die-head and the cutting-off tool. This machine weighs about 4,000 lbs. and is made by the Standard Engineering Company of Ellwood City, Pa.

Mechanical Draft.—Referring to this subject the *Engineering Review* (London) in a recent issue, states that: "By such an arrangement the coal consumption may be increased from the 15 to 20 lbs. per sq. ft. of grate possible with chimney-draft to 30 to 40 lbs. per ft. under ordinary conditions, and beyond this amount under special circumstances. This results not only in a proportionate increase of steaming capacity in the boilers, but in a greater efficiency of combustion, and consequent economy. Most steam-boiler plants nowadays are provided with economizers. Where such is the case an opening is made in the flue between the economizers and chimney, and the fan inlet connected thereto by a short brick or metal flue. Another opening is made in the main flue at a point nearer the chimney, or into the chimney itself, and this opening is connected to the fan outlet in the same way as to the inlet. Between the openings, and inside the main flue, is placed a damper, so that all gases after leaving the boilers must of necessity pass through the fan on their way to the chimney, so long as the damper is closed. It is also customary to place dampers both at the inlet and outlet of the fan, so that by manipulating these two and the one in the main flue, the fan may be cut out, and natural draft resorted to in case of necessity. The same arrangement applies where no economizers are installed, and in such cases the fan handles the gases at the high temperature at which they leave the boilers."

An Ancient Makeshift.—A peculiar locomotive which was built in the year 1874 is at present at work at the Coed Taloa Colliery, North Wales. The frame and wheels are the remains of an old coal wagon, and upon this frame has been fixed an old portable engine, the motion of the main shaft being communicated by cog wheels to the axle of the wagon, geared in such a manner as to add considerably to its power. The speed limit is six miles per hour.

MOTOR-DRIVEN SHAPER.

The 25-in. crank shaper illustrated in the photograph is driven through a Morse silent chain by a 3½-h.p. Crocker-Wheeler variable speed motor, which is mounted on an extension of the base at the rear of the machine. The back gears, which are operated by a lever at the rear, and the variable speed motor afford a range of speeds of from 6 1-3 to 44 strokes per minute. The motor controller and switch are placed on the side of the column within easy reach of the operator.



MOTOR DRIVEN CRANK SHAPER.—JOHN STEPTOE SHAPER COMPANY.

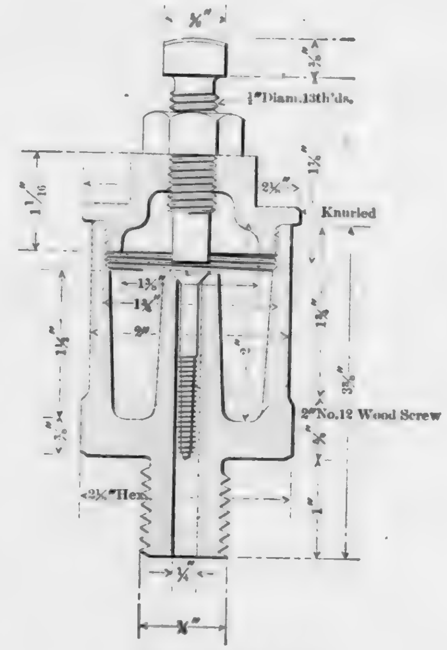
The feed mechanism and the crank for adjusting the length of the stroke may readily be adjusted by the operator from his position in front of the machine. The top of the table measures 16 by 25 ins. It is slotted on three sides and can easily be removed, thus allowing work to be fastened to the slotted apron to which it is attached. The table has an automatic cross feed of 27½ ins. and a vertical adjustment of 14 ins. An opening under the ram will admit shafts as large as 3½ ins. in diameter for cutting keyways.

The lever at the rear of the graduated head allows it to be loosened and swiveled to any angle and instantly fastened in place. The tool head has an adjustment of 9 ins. All feeds are automatic and can be adjusted while the machine is in motion or at rest. The vise is graduated and can be swiveled to any angle desired. The jaws are of steel, 2¼ by 12 ins., and can be separated to take work as wide as 15 ins. This shaper is manufactured by the John Steptoe Shaper Company of Cincinnati, Ohio.

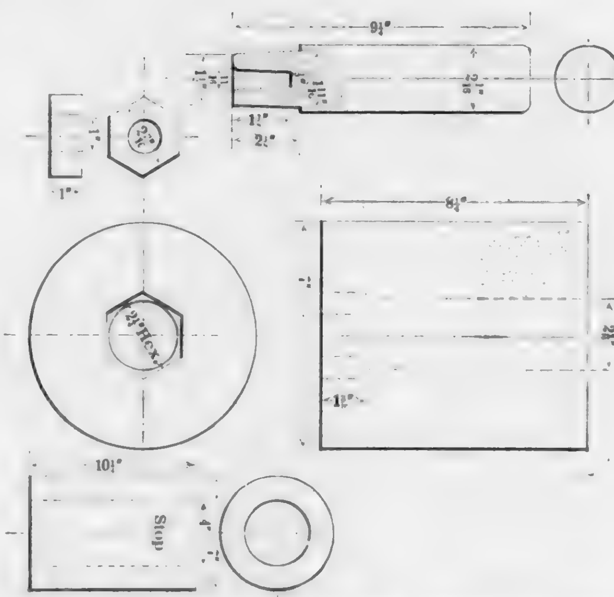
AIR OPENINGS UNDER LOCOMOTIVE GRATES.—If it is desired to determine whether or not the amount of damper opening is sufficient on an engine which is in service, multiply the coal burned per minute by 18, and divide the result by .07, which gives us the cu. ft. of air required per minute. (The authors present curves for obtaining the area required to pass this volume.) In comparing engines of the older classes with those of to-day, we find that the damper opening has been gradually reduced; while on the little old engines of the past it was ample and figured close to what it should be by the method proposed above, the space for damper opening is scarce on some of the later types of locomotives. As there is a direct loss of heat where the air supply is not adequate, sometimes reaching 25 per cent., it shows us that this ashpan subject is one which should not be forgotten in designing a new locomotive, or improving one which is in service, and it is safe to say that a large saving in fuel can be accomplished by increasing the damper openings in our recently built locomotives.—*Messrs. Kinsell, Lynch and Shepard, before Northwestern Railway Club.*

WROUGHT IRON SIDE-ROD OIL CUPS.

We have received drawings of wrought iron side-rod oil cups, together with the punches and dies used in making th m. These cups are made under a steam hammer and at one bl w.



SIDE ROD OIL CUP.



DIES FOR MAKING WROUGHT IRON SIDE-ROD OIL CUPS.

They are very satisfactory in service and much cheaper tha the brass cups ordinarily used; they overcome the weakne of the brass cups at the bottom of the strap fit. These cu are in use on a well known railroad, and the idea seems to b an excellent one.

GAS PRODUCERS VS. BOILERS.—The most economical boiler i as efficient as the most economical gas producer, but in dail practice the advantage would be on the side of the latter. Th maximum efficiency of each is about 85 per cent., but for every day work the steam boiler would not average more than 6 to 65 per cent., and the gas producer 65 to 70 per cent. Bu the greatest economy is in the gas engine itself, which, accor ing to public tests, exceeds in thermal efficiency the best fi ures for the steam engine by about 65 per cent.—*J. H. Hami ton, before South Staffordshire Iron & Steel Institute.*

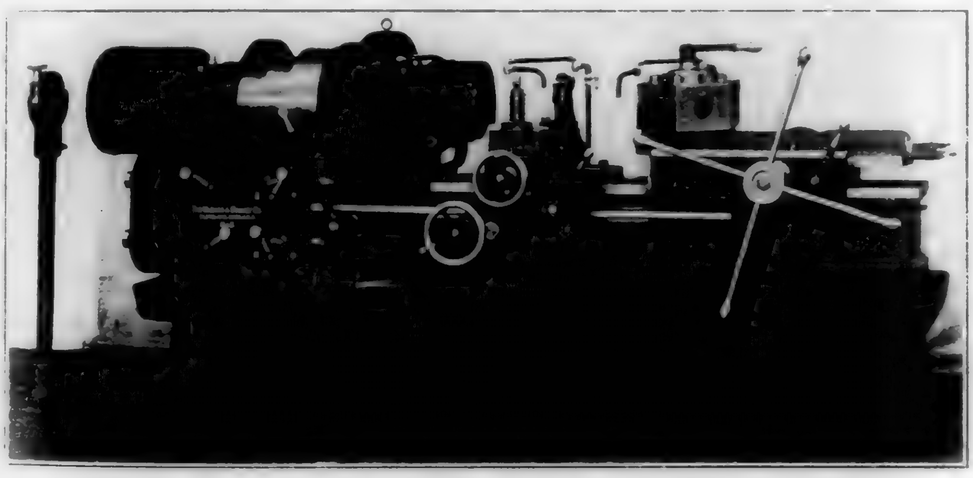
NEW TURRET SCREW MACHINE.

..e head and bed of the turret screw machine, shown in the ..graph, are cast in one piece, to insure strength and rigid- It has a 20-in. swing over the bed, and is equipped with ..utomatic chuck, which will take bar stock of any shape ..o 3⅝ ins. in diameter. The turret slide has 14 ins. travel. ..ve spindle speeds, from 15 to 156 r.p.m., are provided. back gears are thrown in and out by means of friction ..hes. A 4-in. driving belt is used.

..system of compound levers, operated by the long lever ..ont of the head, gives a powerful movement for closing jaws of the automatic chuck; the same lever also engages disengages the power roller feed. The turret slide is ..ided with a supplementary taper base, by means of which ..center of the tool holes in the turret can be adjusted to the exact height of the center of the spindle. Taper gibs, fitted the whole length of the saddle on each side, provide means of adjusting the slide sideways. The slide is equipped with a geared automatic feed, with four changes in either direction.

The turret is hexagon in form, has six tool holes 2½ ins. in diameter, and also bolt holes for attaching the tools to the faces. It is so arranged that any stock smaller than the diameter of the tool holes can pass entirely through it. The index is nearly the full diameter of the turret, and the lock bolt is placed directly under the working tool. Independent adjustable stops are provided for each face. The carriage has a geared automatic cross feed with four changes, and a hand ..ngitudinal feed. In addition to the tool post provided for ..ming and turning tools is a holder for cutting off tools. The turret and carriage feeds are independent of each other, ..l are both provided with adjustable automatic trips. All ..ls are geared, and can instantly be changed by means of ..ers.

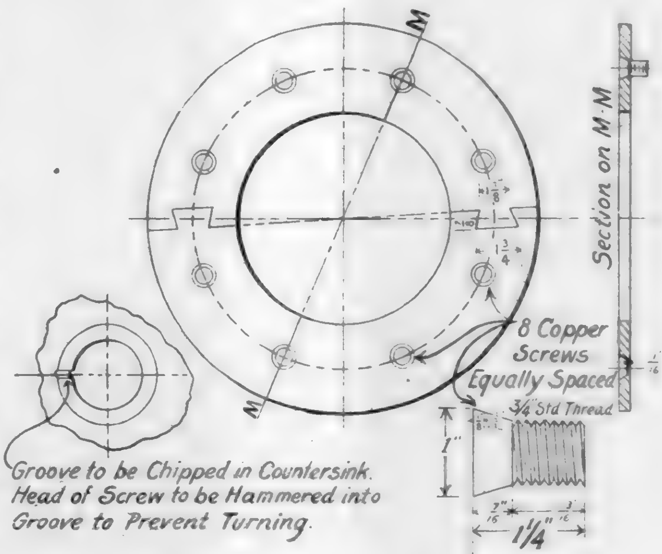
..geared pump delivers oil to the cutting tool for both the ..ret and the carriage through two systems of piping. The ..np operates when running in either direction. A motor ..ve can readily be applied to the machine if desired. The ..ght of this machine, which is made by the Warner & ..asey Company, Cleveland, Ohio, is about 6,000 lbs.



NEW TURRET SCREW MACHINE—WARNER & SWASEY COMPANY.

GOOD DEVICE FOR SECURING HUB LINERS.

..mong many crude methods of securing hub liners there is ..occasional good one. This engraving illustrates a simple ..used with satisfaction by the Boston & Maine for years. ..pper screws with countersunk heads are used. After ..holes in the liners are countersunk a groove is cut along ..countersunk surface with a small round-nosed chisel. By ..ving a little surplus material in the heads of the copper ..ews they are hammered down as in riveting and the copper ..ced into the groove. This forms an effective resistance to the loosening of the liner, as the screws cannot turn backward because the "feather" on the head of the screw prevents it from moving. This drawing was received from Mr. H. O. Keay, chief draftsman of the motive power department of the road.



DEVICE FOR SECURING HUB LINERS.

INCANDESCENT LAMPS.—When Edison first made the small incandescent electric lamps, consisting of a carbon filament fixed by platinum wires in a pear-shaped glass bulb, from which the air had been exhausted, the cost was $3 each; now there are many million similar lamps of better quality made each year and sold at less than 20 cents each.—*Mr. Alex. E. Outerbridge, Jr., Am. Academy of Political and Social Science.*

The available coal supply in England is estimated at 100,914 million tons, which will meet the demands for the next 400 years.

DEVELOPMENT OF THE GAS ENGINE.—Since the manufacturers of the gas engines guaranteed an effective horse power by the consumption of 18 cu. ft. of gas of 135 calories (the usual quality of city gas), the use of the engines has multiplied rapidly. In German cities from 15 to 25 per cent. of the total output of the gas works is supplied for operating gas engines, while in Paris something like 5 per cent. of the total output is utilized in this way. There are few, if any, American cities where even 1 per cent. of the gas output is used for operating gas engines. However, the steady development of the industry indicates that changes in this respect may be expected, and that in cities where gas is supplied at $1 or less per 1,000 the gas engine will become an important factor in the industrial life of the near future.—*G. E. Walsh, in Western Electrician.*

FIRE TESTS OF AUTOMATIC SPRINKLERS.—Recent tests were made in the car barns of the Public Service Corporation of New Jersey to show the efficiency of automatic sprinklers. Three cars were fired. In all three cases the fire was confined to the car in which it originated. The first opened 10 sprinklers, and was extinguished in 18 minutes after the first one opened. The second opened 11, and was out in 2½ minutes after the first one opened. The third, using oil over the entire interior of the car, opened 10, and was out in 4¼ minutes after the fire was started. This test showed that the hottest fire was the easiest to put out.

AN IMPROVED UPRIGHT DRILL.

A positive feed mechanism is essential if the maximum efficiency is to be obtained from drilling machines using high speed drills. The feed changing mechanism must be placed within easy reach of the operator and the changes must be such that they may be made easily and quickly. The Cincinnati heavy pattern upright drill shown in Fig. 1 is equipped with the positive geared feed mechanism shown in detail in Fig. 2. By means of the quick change feed box on the sliding head convenient to the operator any one of six feeds (.006,

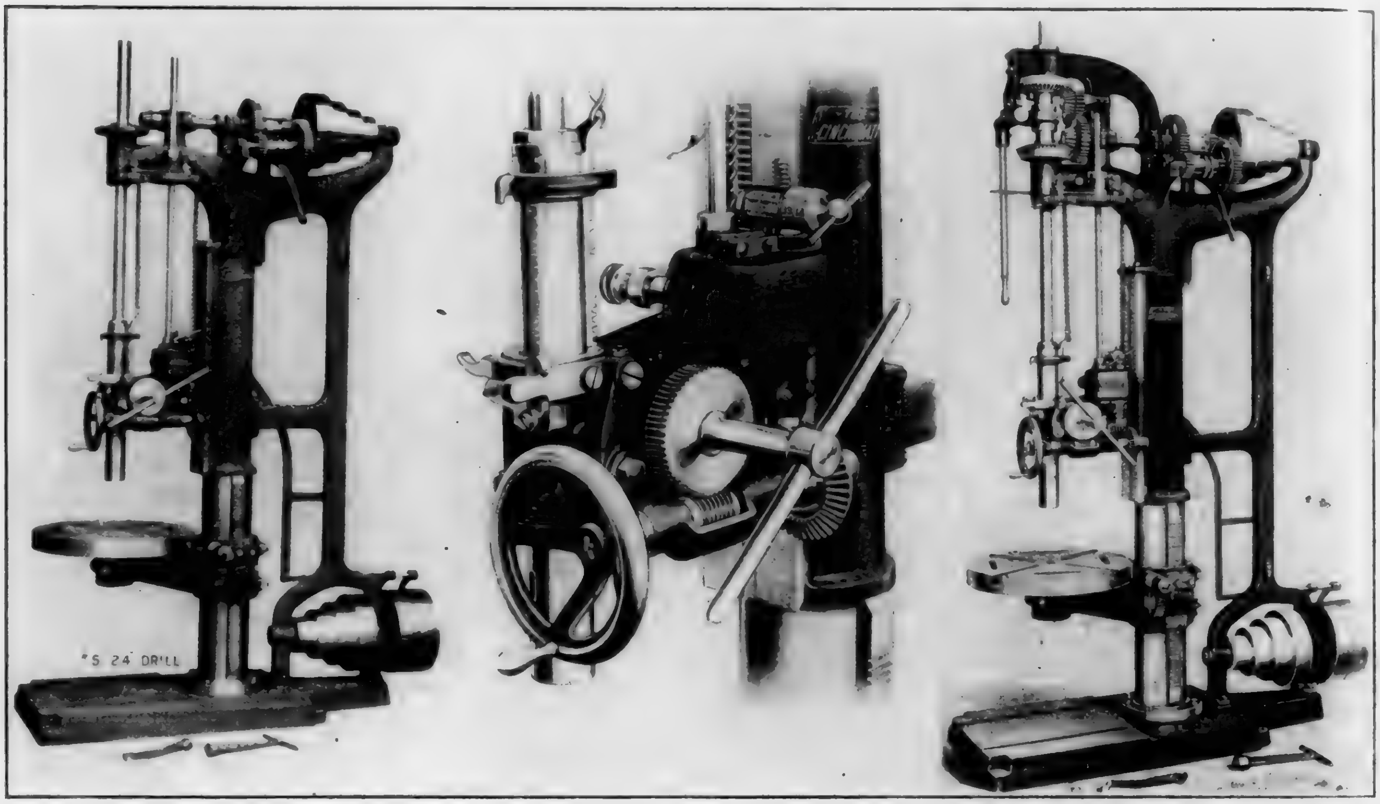


FIG. 1.
STANDARD UPRIGHT DRILL WITH POSITIVE FEED.

FIG. 2.
POSITIVE FEED MECHANISM.

FIG. 3.
UPRIGHT DRILL, WITH POSITIVE FEED AND GEARED TAPPING ARRANGEMENT.

CINCINNATI MACHINE TOOL COMPANY.

.009, .013, .018, .027 and .039 ins. per revolution of the spindle) may instantly be obtained. The feed in use is plainly shown on the index.

The upright drill shown in Fig. 3 is equipped with the positive feed mechanism and also with a patent geared tapping arrangement which is placed on the drill spindle and is operated by the long lever which hangs parallel to the spindle. By means of this lever, which controls a double clutch, the operator may start, stop or reverse the motion of the spindle without using the shifter. The clutches may be engaged or disengaged while the machine is in motion, thereby allowing the operator to drill a hole, remove the drill and substitute a tap and tap the hole without stopping the machine. The spindle has a quick reverse speed of 2 to 1.

These machines are made in 24, 28, 32, 36 and 42-in. sizes by the Cincinnati Machine Tool Company of Cincinnati, who make a strict specialty of upright drills.

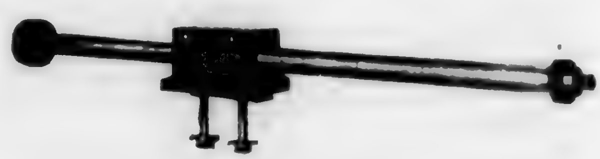
Thermal Storage for Locomotives.—Mr. Druitt Halpin's system of heat storage has been applied to a locomotive boiler of the Great Northern Railway of England. A cylindrical storage tank is placed on top of the boiler, to which it is connected by means of a pipe. The feed water, heated to the same temperature as that of the boiler, is passed through this cylinder, the heating being done by steam taken from the boiler when the engine is standing or the safety valves are blowing. In this way a large supply of heat is available to help the boiler when running. In stationary practice a test by Professor Unwin has shown a coal saving of 19 per cent. with this system.

A HOME-MADE INTERNAL SURFACE GRINDER.

In boring or reboring steel tubes, hydraulic jack barrels or other wrought iron or steel cylinders, where accuracy and smoothness of bore are essential, it is often impossible to obtain satisfactory results by machining with the ordinary boring tools. In an attempt to overcome the difficulties, caused by tool marks, of roughness from chattering and of taper bore, in hydraulic cylinders, the interesting little grinding appliance, here shown and described, was designed by Mr. L. L. Smith, M. E.

The device consists of a ¾-in. diameter steel shaft, which is enclosed within and arranged to revolve inside a steel tube of 1 in. inside diameter and 40 ins. long. The shaft is supported and given bearing by bronze bushings pressed into the ends of the tube. One end of the shaft carries an emery wheel, which may vary in diameter from 2 ins. upward, according to the character of the work required; the other end carries a driving pulley for a 1 in. belt.

The grinder is bolted on the carriage of an ordinary engine lathe, with the axis of the grinding shaft carefully paralleled



INTERNAL SURFACE GRINDER FOR ORDINARY LATHE.

to the center line of the lathe, by means of the clamp-block shown in the engraving. The cylinder or tube to be finished by grinding is set up and centered in the lathe, with one end in the chuck and the outer end supported by a steady rest. The cylinder is rotated slowly by the lathe in one direction of rotation, while the emery wheel is driven at about 3,500 r. p. m. in the opposite direction from an overhead drum. The grinder is fed back and forth in the cylinder until the desired finish is obtained.

This device is valuable for smoothing the inside surface of

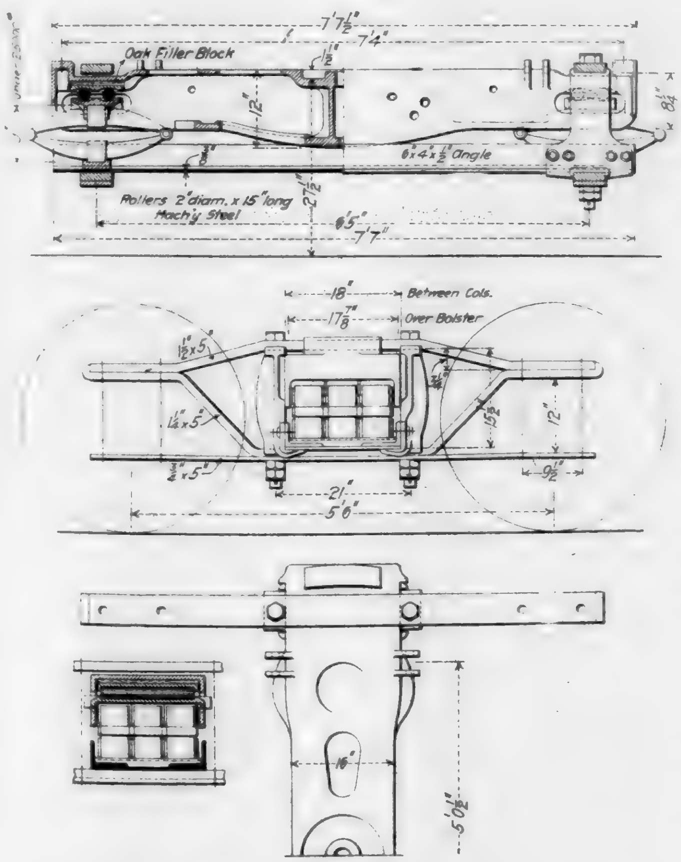
:gh wrought iron pipe to render it suitable for air hoist or · jack purposes. It is also well adapted to the internal nding of a large variety of small work, such as hardened shings, collars, etc. It is a very effective tool and is one .t can be used to great advantage in any machine shop.

BARBER TENDER TRUCK.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

The type of truck construction developed by Mr. J. C. Barber, f the Standard Car Truck Company, Chicago, is a noteworthy success in the severest service in the country. It provides side motion for the bolsters by means of rollers and involves a principle which is becoming exceedingly important in connection with the breakage of flanges of cast iron wheels under ars of large capacity.

A recent application of this type to the trucks of 7,000-gallon tenders on the "Rock Island" is illustrated in the accompanying drawing. This is an ingenious combination of elliptic springs, rollers, a cast steel truck bolster and a low arch-bar truck. The problem was to get the rollers into a combination



BARBER TENDER TRUCK.—CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

this kind without thinning the ends of the bolster too much d yet to keep the parts low enough for the available space. It was accomplished by combining the lower roller seat and per spring seat in a casting provided with lips to enclose e columns and by providing slotted openings through the ds of the bolster for these castings to pass through. The arngement provides for the springs under the hollow bolster d the rollers are inside the bolster, the effect being to thin e bolster ends down to a single thickness of cast steel sufficent for the upper roller seat to bear against, and yet there is sacrifice of strength of the bolster. This is clearly indited in the engraving. These trucks are reported to be very atisfactory in service.

Ideas in Motion.—You have all had ideas and you will have more of them. These mental forces, like other forces, only do work when in motion. Hence your ideas are only valuable when put into execution, and this often requires more talent than to originate them. Some men seem to consider their ideas so good that they will execute themselves.—*Walter C. Kerr.*

"I have been a close observer of successful men, and few do more than sprout, up to the age of thirty-five; and if by that time they have builded well and upon a sure foundation, their chances for success are more than even. Setbacks, disappointments and mistakes are frequently the making of men. Uninterrupted success, as a rule, is dangerous.—*Francis H. Peavey.*

Opportunities.—We hear much about opportunities. They are everywhere plentiful. Remember that your opportunity is the little one that lies squarely in front of you, not the large one which you hope to find further along. Many a man is surrounded with opportunities who never seizes one. There are traditions that Adam, William Tell, and Sir Isaac Newton each had an affair with an apple, but with different results.

Walter C. Kerr.

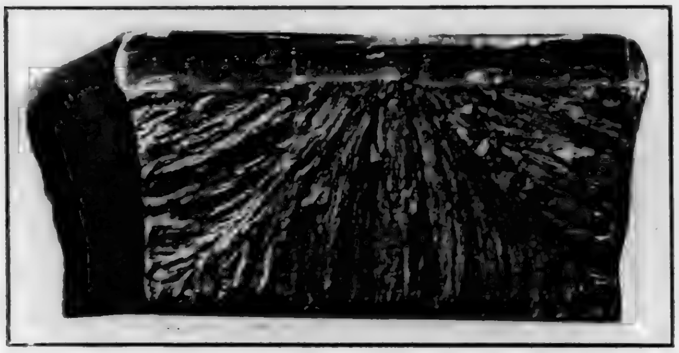
Encouragement in Promotions.—Every man should be encouraged. Believe that he can do better things than he is now doing or that he can do the things he is now doing in a better way and with advantage to himself. Every promotion should be with the prime idea of strengthening the machine, of making the organization stronger—more capable. The promotion should be made, not only to supply a place with a needed piece of material, but to so fill that place that the setting will be complete and harmonious, that the selection and promotion will be approved of men.—*W. R. Heath, before Central Railway Club.*

Production Improvements.—To show the difference in cost where different machinery or improved processes are used. For making one hundred ¾-in. by 4-in. hexagonal head finished bolts, on a modern turret lathe, by reducing the body of the bolt from a commercial bar of hexagonal steel of a size required for the head, the cost is $15.84. Similar bolts are now made by a machine-screw company by welding electrically the head (cut from a bar of hexagonal steel) to the body of the bolt, made from a piece of cold rolled steel the exact diameter of the bolt, and sold for $5.88, which shows a saving in favor of this process of approximately 63 per cent.—*Mr. Alex. E. Outerbridge, Jr., Am. Academy of Political and Social Science.*

Cheap Power from Producer Gas.—The cost of running engines with producer gas is, in fact, so low that installations are being laid down in Grenoble, where an enormous capital has been spent upon the creation of hydro-electric plants. It was expected that the price at which electrical energy could be supplied by the huge plants in the Dauphine would allow of electricity supplanting every other form of motive power throughout the entire district. This price has been still further cut by producer gas. A few instances of working cost may be interesting. One user states that the fuel consumption for an 8-h.p. engine amounts to $1.31 for 64 hours; in another case the total working cost for a 22-h.p. engine is 80 cents a day; while a 22-h.p. oil engine, costing $2.80 a day, was replaced by a 25-h.p. engine running with producer gas, and the daily expense was reduced to 60 cents. In these cases Anzin coal or anthracite was employed. These results are so striking that producer gas plants are attracting considerable attention in France, where good fuel is not procurable except at a high figure, and further trials with the Pierson suction plant are to be carried out shortly by the French Institute of Gas Engineers, at which trials it is probable that the British Institution of Gas Engineers will be represented.—*The Engineer, London.*

A NEW ANTI-FRICTION METAL

A new feature in the line of anti-friction metals is shown in the photograph which illustrates a piece of metal which has been nicked on one side and after being placed in a vise has been broken off by a sharp blow from a heavy hammer. A fibrous and stringy mass is revealed. The alloy is of a tin and aluminum base and the fibers always radiate from the chilling surfaces, regardless of the number of times it is reheated, thereby presenting the ends of the fibers to the wearing surfaces and thus increasing its wearing capacity and its ability to resist crushing. The metal is very tough and its texture is fine and smooth with no granular matter intervening. Under the most severe tests and shocks it does not become brittle. It may be remelted an indefinite number of times without becoming hard or losing any of its original properties, and is especially adapted for use in the linings of



A NEW ANTI-FRICTION METAL, SHOWING FRACTURE.

driving box and engine truck brasses, eccentric straps, crosshead gibs, steam and gas engine bearings, wood working and all kinds of high speed machinery.

This metal, together with some new bronzes and a "copper-steel," or hardened copper composition, will be placed on the market by the Buda Foundry & Manufacturing Company of Chicago, who will in the future make this an important branch of their increasing business which in the past has been largely confined to track supplies.

The thermal efficiency of gas engines is about double that of the best steam engine of the same power, which means that if fuel in the form of a gas could be obtained equally as cheap in proportion to the heat produced as that in coal, gas engine power would cost only one-half of that of steam engine power. Engines of this type are made so as to burn cheap oils or gas made from the vaporization of oil directly in the cylinder, and certain types of this class of engines are in extensive use. A cheap form of gas known as producer gas can be made in a producer from coal. The producer would probably have an efficiency of about 60 per cent. or 20 per cent. less than a steam boiler. This producer gas could be burned in a gas engine giving an efficiency of probably 30 per cent., so that we should have a joint efficiency of about 18 per cent., which is probably 50 per cent. better than has ever been done in a steam engine.—*Prof. R. C. Carpenter, in Power and Transmission.*

Sustained high speed is a matter of finance.—*F. J. Sprague.*

Mr. W. P. Sproul has been appointed master mechanic of the Atlantic Coast Line, with headquarters at Savannah, Ga., to succeed Mr. F. S. Anthony, resigned.

MR. J. F. DEEMS.—The jurisdiction of Mr. Deems, general superintendent of motive power, rolling stock and machinery of the New York Central Lines, has been extended over the Michigan Central and the Cleveland, Cincinnati, Chicago & St. Louis, thus adding to his already great responsibilities those of 1,000 locomotives and 37,000 cars, running on 3,600 miles of track.

PHOENIX IMPROVED TENDER SPRING.

This spring, of which a double elliptic is illustrated, is provided with end plates and connections arranged for easy assembling and repairs. Instead of using eyes or scrolls at the ends of the plates with a connecting bolt, which necessitates a curved neck in the end of the leaf, the ends of the halves are connected by malleable rockers, which retain the springs in their proper relative positions. Their longitudinal end pockets and central flanges confine the ends in alignment, preventing twisting, and providing seats for the ends of the

A NEW TENDER SPRING.

halves, over which the springs may move easily when elongated or contracted by changes in loading. With light loads or no loads the bearing is at the extreme ends, and when compressed on the rocker castings the springs are shortened, and the bearing is increased in proportion to the load. If a leaf in any section breaks the section is easily removed and a new section, from stock, is quickly put in place, without requiring the services of a special machine to make a scroll on a new one. These malleable rockers are adapted to any desired number of halves. These springs require no forging which tends to weaken the metal. They are guaranteed for a service of two years. These springs are manufactured by the Phœnix Car Spring Company, Rookery Building, Chicago, Ill., from whom they may be obtained in any desired size.

MAKING PRECEDENTS.—A man who has learned by experience to do a thing deserves no credit for doing it right. He is then only a repeating machine. Real power is characterized by ability to perform right the first time that which a man never did before.—*Walter C. Kerr.*

TWO PRESSURES FROM ONE COMPRESSOR.

By means of the new "skip" valve introduced by the Norwalk Iron Works Company, pressure of from 80 to 100 lbs. for operating pneumatic tools, and 20 to 25 lbs. for sand blasting, painting, etc., are taken from the same compressor, and these pressures are automatically maintained. These valves are used as the inlet valves of the second cylinders of two stage compressors, and the low pressure mains are supplied from the intercooler, between the two stages of compression. If the pressure in the intercooler falls below a predetermined point, the skip valves remain open, and the second cylinder rejects its supply of air, throwing it back to the intercooler. The skip valve automatically adjusts the amount, remaining open any number of revolutions, or only part of a revolution, as required. The speed and pressure governors regulate the speed of the machine to meet the demands of both high and low pressure systems. With these arrangements, any quantity of air within the limits of the machine may be drawn off at any time, and the speed is automatically adjusted to suit. This avoids the necessity of operating two compressors and reducing valves if but one compressor is employed. Further information concerning this interesting improvement may be had from the manufacturer, who may be addressed at South Norwalk, Conn.

PERSONALS.

r. L. J. Miller has been appointed master mechanic of the ...souri Pacific, with headquarters at Atchison, Kan.

r. Maurice Prendergast has been appointed general fore- ... of the shops of the Baltimore & Ohio at Fairmount, W. Va.

Ir. W. A. Stearns has been appointed assistant master ...hanic of the Louisville & Nashville at Louisville, Ky.

Ir. R. H. Rogers has been appointed master mechanic of ... New York, New Haven & Hartford Railroad at South ...ston, Mass.

Mr. C. G. Arthur has been appointed master mechanic of ... Southern Railway at Columbia, S. C., to succeed Mr. J. F. ...han.

Mr. W. E. McEldowney has been appointed master mechanic ... the Denver, Enid & Gulf Railroad with headquarters at ...d, Okla.

Mr. F. A. Beckert has been appointed master mechanic of ... Louisville & Nashville, with headquarters at Knoxville, ...

r. A. C. Hinckley has been appointed master mechanic of ... Cincinnati, Hamilton & Dayton at Lima, Ohio, to succeed ... J. E. Gould.

Mr. W. L. Tracy has been appointed master mechanic of the ...uisville Terminals of the Louisville & Nashville Railroad ... Louisville, Ky.

Mr. Albert Nugent has been appointed master mechanic of ...e Spokane Falls & Northern, with headquarters at Spokane, ...h., to succeed Mr. C. H. Prescott.

Ir. H. H. Kendall has been appointed superintendent of motive power of the St. Louis, Brownsville & Mexico Railway, with headquarters at Kingsville, Texas.

Mr. E. G. Haskins has been appointed master mechanic of the Denver & Rio Grande with headquarters at Salida, Col., ... succeed Mr. A. C. Hinckley.

... F. R. Cooper has been appointed master mechanic of ... Georgia, Florida & Alabama, and the Carrabelle, Talla-...ee & Georgia, with headquarters at Bainbridge, Ga.

Mr. George Wagstaff has been appointed supervisor of boilers ... the Vanderbilt system, with office at Buffalo, reporting to ... general mechanical engineer, Mr. F. M. Whyte.

Ir. F. Mertsheimer has resigned as superintendent of motive ...r of the Denver & Rio Grande to succeed Mr. C. H. Cory ...uperintendent of motive power of the Cincinnati, Hamil- & Dayton, with headquarters at Lima, O.

... C. E. Boss has been appointed acting master mechanic ...e Ft. Worth & Rio Grande and the St. Louis, San Fran- ... & Texas Railways, with headquarters at Sherman, Tex., ...ucceed Mr. H. C. McKelvey, resigned.

... W. A. Johnson has been appointed general foreman of ...hinery and equipment of the Manistee & Grand Rapids ...lway with headquarters at Filer City, Mich. He was for-...ly master mechanic of the Iowa Central.

...r. M. D. Franey has been appointed superintendent of ...s of the Lake Shore & Michigan Southern Railway at ...inwood, Ohio. He was formerly general foreman of the ...higan Central shops at Jackson, Mich.

...r. B. A. Worthington, assistant director of maintenance ... operation of the Harriman Lines, has been appointed gen- ... manager of the Oregon Railway & Navigation Company, ...h headquarters at Portland, Ore.

Mr. H. C. Bayless has been appointed mechanical engineer of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn.

Mr. Alfred Lovell, heretofore assistant superintendent of motive power of the Atchison, Topeka & Santa Fe Railway, has been appointed superintendent of motive power, with headquarters at Chicago, Ill.

Mr. A. W. Wheatley, general master mechanic of the Northern Pacific, has resigned to accept the position of superintendent of shops of the Chicago, Rock Island & Pacific at East Moline, Ill. The appointment of a man of Mr. Wheatley's attainments in charge of a shop plant indicates the importance in which the operation of a large and expensive plant is held by the management of this road. It is to be hoped that this appointment marks a new era in railroad shop management.

Mr. T. R. Brown has been appointed engineer of steel car construction of the American Car and Foundry Company, with headquarters in New York. He is widely known as formerly master mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona, later as works manager of the Westinghouse Air Brake Company, and general manager of the Corrington Air Brake Company. Mr. Brown is eminently well fitted for his present position, where he can bring to bear in matters of car design, experience in building locomotives and cars, and wide manufacturing experience, supplemented by intimate knowledge of railroad conditions.

BOOKS.

Poor's Manual of Railroads.—The Railroad Manual Appendix, containing the fifth annual compilation of Poor's Ready Reference Bond List has been issued. It brings up to date tables of dividends and annual meetings, stock registrars and transfer agents. In addition to the appendix a revised statement of the Rock Island system has been received. This is revised to June 30, 1904, and is to take the place of the statement appearing on pages 756 and 757 of Poor's Manual for 1904.

Traveling Engineer's Association. Proceedings of the Twelfth Annual Convention. Edited by W. O. Thompson, secretary, Oswego, N. Y.

This volume contains the reports, papers and discussions of the convention held in Chicago in September, 1904. Conspicuous among the subjects are, the selection, training and examinations of firemen, water tube boilers, valve motion, the high speed brake, headlights, the four-cylinder balanced compound locomotive, the last mentioned subject being introduced in paper by Mr. W. J. McCarroll of the Baldwin Locomotive Works. This volume also contains the constitution, by-laws and list of members of the association.

Fowler's Mechanical Engineer's Pocket Book. 1905. By W. H. Fowler. London, Scientific Publishing Company. Leatherette, 500 pages, pocket size. Price, 1s. 6d.

This edition includes substantial improvements over previous ones. It contains a new section on entropy and its appliaction to steam engine practice and this subject is well treated to suit the needs of ordinary students. The additions fill 50 pages, including a number of useful tables and information concerning steam turbines and high speed tool steel, every grinding, milling, reaming and other machine tool subject. The book has been entirely revised and amended to keep it up to current practice. It is a useful book.

The New York Subway: Its Construction and Equipment. Published by the Interborough Rapid Transit Company, 150 pages, 10 by 14 inches in size, profusely illustrated, boards, New York. 1904.

This fine record of the Subway is a fitting tribute to the men who have successfully carried this remarkable enterprise to completion and operation.

The introduction is historical. Chapter I gives the route of the road and location of stations, also photographs and plans of typical stations. Chapter II presents types and methods of construction and illustrates the difficulties encountered. Other chapters deal in detail with the powerhouse, the power plant, the system of electrical supply, electrical equipment of cars, lighting system for stations and tunnels, cars and tracks, signal system, drainage, repair

sheds and the closing chapter gives the names of the sub-contractors. The letter press and engravings are beyond criticism and great credit is due the McGraw Publishing Company, under whose direction the volume was prepared. The book is worthy of the great work which it so satisfactorily records.

NEW CATALOGUES.

IN WRITING FOR THESE CATALOGUES PLEASE MENTION THIS PAPER.

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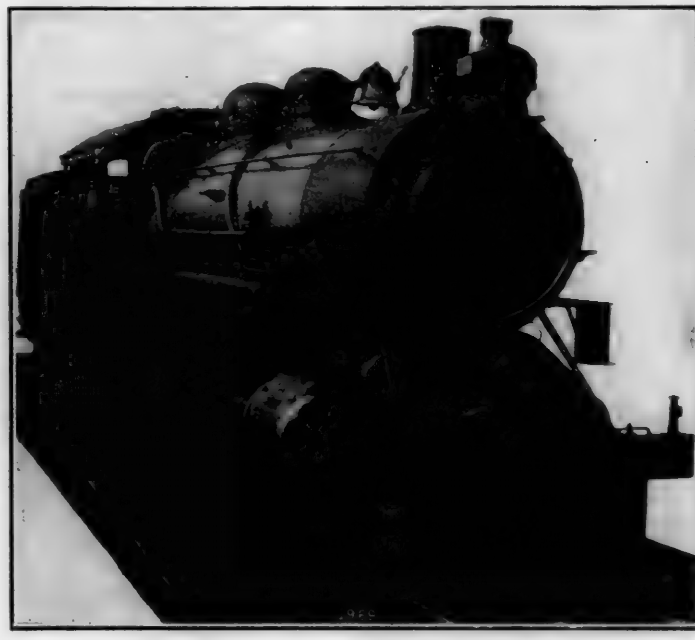

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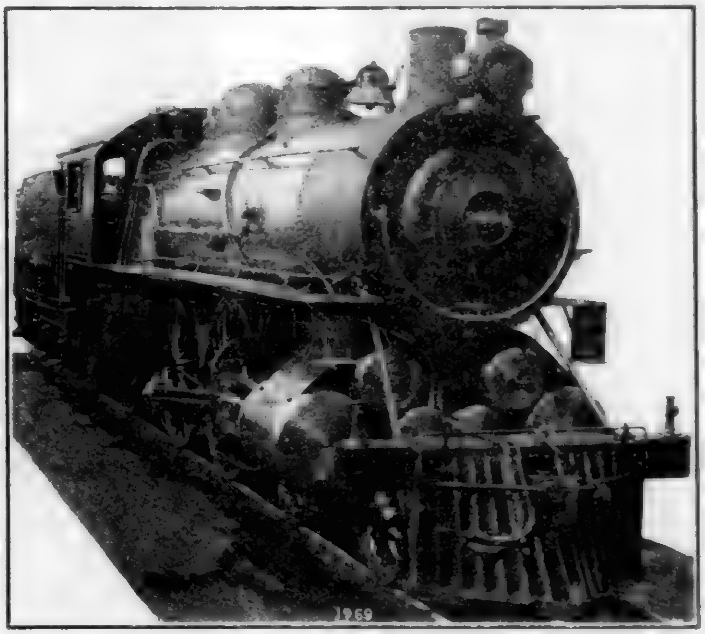

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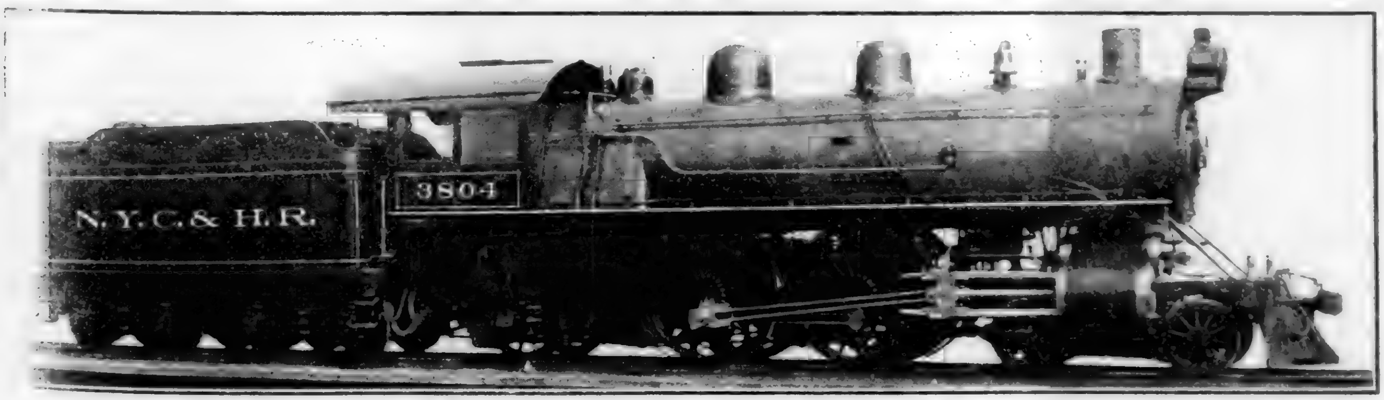

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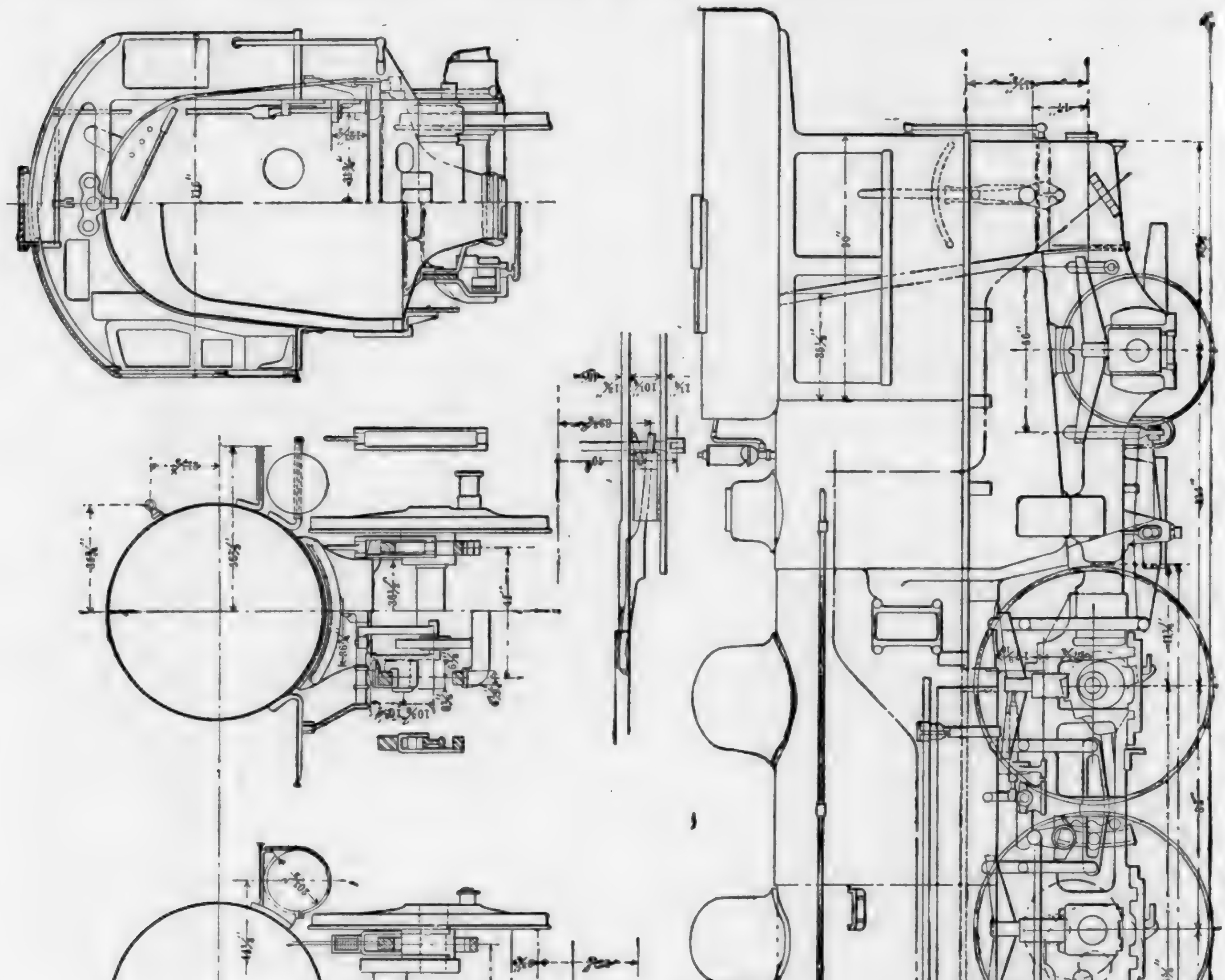

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this point becomes heated in passing down through the steam pipes before it reaches the cylinders, which should be an advantage.

In general the new design resembles in its principal details the original engine and the Cole compound, the details being sufficiently similar to permit of a satisfactory comparison of the different arrangements of cylinders. It will be noted that the cylinders are exactly the same in diameter in both of the compounds. The leading dimensions of the three designs mentioned may be compared by aid of the accompanying table.

While the frames are necessarily different from the others, in order to accommodate the increased length of wheel base and the cylinders in one casting, in general they are similar to the other two designs. The front driving journals are 10 x 10¾ ins., the rear 9½ x 12 ins. The truck wheels are 36 ins., with 6¼ x 10-in. journals, the trailing wheels being 50 ins.,

8 x 14-in. journals. Ten tons of coal and 6,000 gals. of r are carried on the tender, which is New York Central lard. The comparative table of dimensions follows:

NEW YORK CENTRAL ATLANTIC TYPES COMPARED.

—Drivers	4-4-2	4-4-2	4-4-2
—Name	Atlantic	Atlantic	Atlantic
ber of road or class	980	3000	3804
ler	Sch'n't'dy	Cole Balanced.	Baldwin Balanced
le or compound	Simple	Compound	Compound
n built	1901	1904	1905
ght, engine total, lbs	176,000	200,000	204,500
ht, on drivers, lbs	94,800	110,000	106,820
ht, on leading truck, lbs	42,600	50,000	53,460
ht, on trailing truck, lbs	38,600	40,000	44,220
ght of tender (loaded), lbs	112,000	121,600	120,500
el base, driving, ft. and ins	7-0	7-0	7-0
l base, total, engine, ft. & ins.	27-3	27-9	30-9
el base, total engine and nder, ft. and ins	58-0	53-8	56-3
iving wheels, diameter, ins	79	79	79
Cylinders, diameter, ins.	21	15½	15½ & 26
Cylinders, stroke, ins	26	26	26
Heating surface, firebox, sq. ft	180	175	180
Heating surface, arch tubes, sq. ft.	27.1	23	
Heating surface, tubes, sq. ft	3,298.1	3,248.1	3,465
Heating surface, total, sq. ft	3,505.2	3,446.1	3,645
Firebox, length, ins.	96⅛	96⅛	96⅛
Firebox, width, ins.	75⅝	75¼	75¼
Grate area, sq. ft.	50.3	50.23	50.3
Boiler, smallest diameter of, ins	72	72¼	72⅛
Boiler, height of center above rail, ft. and ins	9-8	9-3 1-16	9-3
Tubes, number & diameter in ins	396-2	390-2	318-2¼
Tubes, length, ft. and ins	16-0	16	18-6
Steam pressure, lbs., per sq. in	200	225	
Type of boiler	Straight	Straight	Straight
Fuel	Bitum. coal	Bitum.	Bitum.
Reference in American Engineer and Railroad Journal	Feb., 1901 P. 35	May, 1904 P. 184	April, 1905

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

PARIS.

In estimating the value of foreign railway practice it is wise to look beyond the equipment itself. We can not use foreign locomotives or cars and foreigners cannot use ours, simply because they would be misfits, being developed to meet entirely different conditions. Americans return from abroad saying that we have little to learn from foreigners. Their cars are mere boxes and their locomotives are small. This is true, but if we look deeper and discover the foreign methods of developing their equipment and the methods of operating it we find a wealth of ideas which are worthy of study and emulation. This applies to France, to England, and to Germany. In France, where I found the mechanical engineering as well as the operation of the locomotive carried to the highest point, the motive power officials themselves are worthy of study. These gentlemen stand among the highest engineers of the country. Their work is appreciated and they have performed a very important part in the transportation development of the continent.

One characteristic of their work is that of knowing what is to be required and providing for it carefully in advance. They ccupy leading positions in railway administrations and are nsulted. No administration in France would dare to take e responsibility of ordering locomotives without depending bsolutely upon the motive power department for the design. d even the smallest detail is left to these officials. Anything e would be contrary to the precedents, the traditions and e business policy of the roads. The result is that the locotive responsibility rests entirely with these officials (in rked contrast to conditions on some of our roads at home). To me there is a deep significance in the fact that French omotives are provided with devices which are perfectly well ndled and which we have not been able to use because of eir "complication." One of these is the variable exhaust. rench runners are taught to use them and they do use them elligently, economically and efficiently. The question arises to why we cannot do likewise, because we need the variable haust.

French motive power men have produced machines which admirably suited to their needs. Their one thought has been to secure the best, and they have brought up the men to handle machines which are very complicated, as judged from our standards. We may criticize construction for lack of convenience in repairs, but we must bow to the traditions under which these officials really direct their departments and conduct their work in accordance with high ideals. To do this they have enjoyed real co-operation with other departments.

I wish specially to acklowledge courtesies received from Messrs. du Bousquet and Rodrigue, of the Northern; Messrs. Solacroup and Laurent, of the Orleans, and Mr. Herdner, of the Southern Railway, with whom I spent most enjoyable but brief moments. The atmosphere of their departments produced a feeling like inspiration, because of the appreciation of the locomotive problem which is everywhere evident. It gives the impression of the commanding importance of motive power and of the officials who have brought the French locomotive to its high place, and have at the same time developed the men to operate them. The perfection of the premium system for locomotive engineers and firemen, used so effectively in France, entitles these officials to the highest praise, particularly those of the Nord, Midi and Paris-Orleans railways. I was not fortunate enough to personally inspect the good work which I know the other roads are doing.

FREIGHT CARS IN FRANCE.

Because French freight equipment is not of large carrying capacity it does not follow that it has no interest for us. These people have much to show us in the use of steel frames. They have adopted steel in light equipment for reasons of economy in maintenance. The moral of this is that if economical where steel is not required for strength, it must necessarily be even more economical for us, because we need the strength of steel as well as its durability. These roads have used iron under-frames for more than 40 years. Since 1869 all the cars of the Eastern Railway have had metal underframes. In this experience the value of the superior resistance to corrosion of large sections has been learned and life of 60 years is expected, or three times the life of wooden frames. What more could be asked?

These cars are from 15 to 25 ft. long and of about 10 tons capacity. Few of them have even hand brakes. If steel frames are advantageous under these conditions, what is to be said of them for ours?

In France steel has replaced wood and the frames were at first too light, many of the older ones being of special rolled sections resembling a letter E. Composite frames succeeded wooden ones, but now the frames are entirely of steel, while in Germany many cars are built entirely of steel. Generally the underframes employ 3 or 5 longitudinal sills of channels or I beams, gussetted to 4 cross bearers and provided with diagonal braces. On these wooden boxes are built.

Each road has as small a number of different types of underframes as possible, but the superstructures are varied to suit traffic requirements of shippers. Most of the cars are built in the shops of the railroads and by the repair forces when not otherwise occupied. In this way the repair organizations are kept together. The repair forces are small because, except for wrecks, the maintenance of the frames is almost insignificant. These people do not know anything of the effect of heavy American locomotives, of our strenuous methods and the destructiveness of our switchmen. As to the corrosion of steel frames, there is not the slightest anxiety in France.

It seems difficult to believe, but I am told that thousands of French cars are maintained for less than $2 per car per year, which, however, does not include painting. A thorough painting once in 3 years is believed to be sufficient to maintain steel underframes satisfactorily. New equipment is provided in accordance with appropriations upon an annual depreciation basis. This was mentioned by Mr. Tolmer, of the Eastern Railway of France, in his article in this journal in April, 1897. On page 120 of that number an interesting diagram of the cost of repairs of French cars was presented. I am

told that this diagram applies to-day. Steel underframes are overhauled when about 15 years old, very little work being required in intervals of 15 years after that. As far as I can learn no metal frames of the heavier sections in ordinary service have ever worn out or corroded to the point requiring them to be discarded. It is apparent that the cost of repairs of the wooden boxes is far greater than that of the metal frames of the same cars.

These people cannot understand our general use of wooden cars for either passenger or freight service. Passenger car construction over here is tending in a marked way toward universal use of steel underframes and increasing use of steel in upperframes. An excellent example of metal work is the metallic window sash of European cars.

My notes cover many other interesting details, but these letters must soon be brought to a close.

G. M. B.

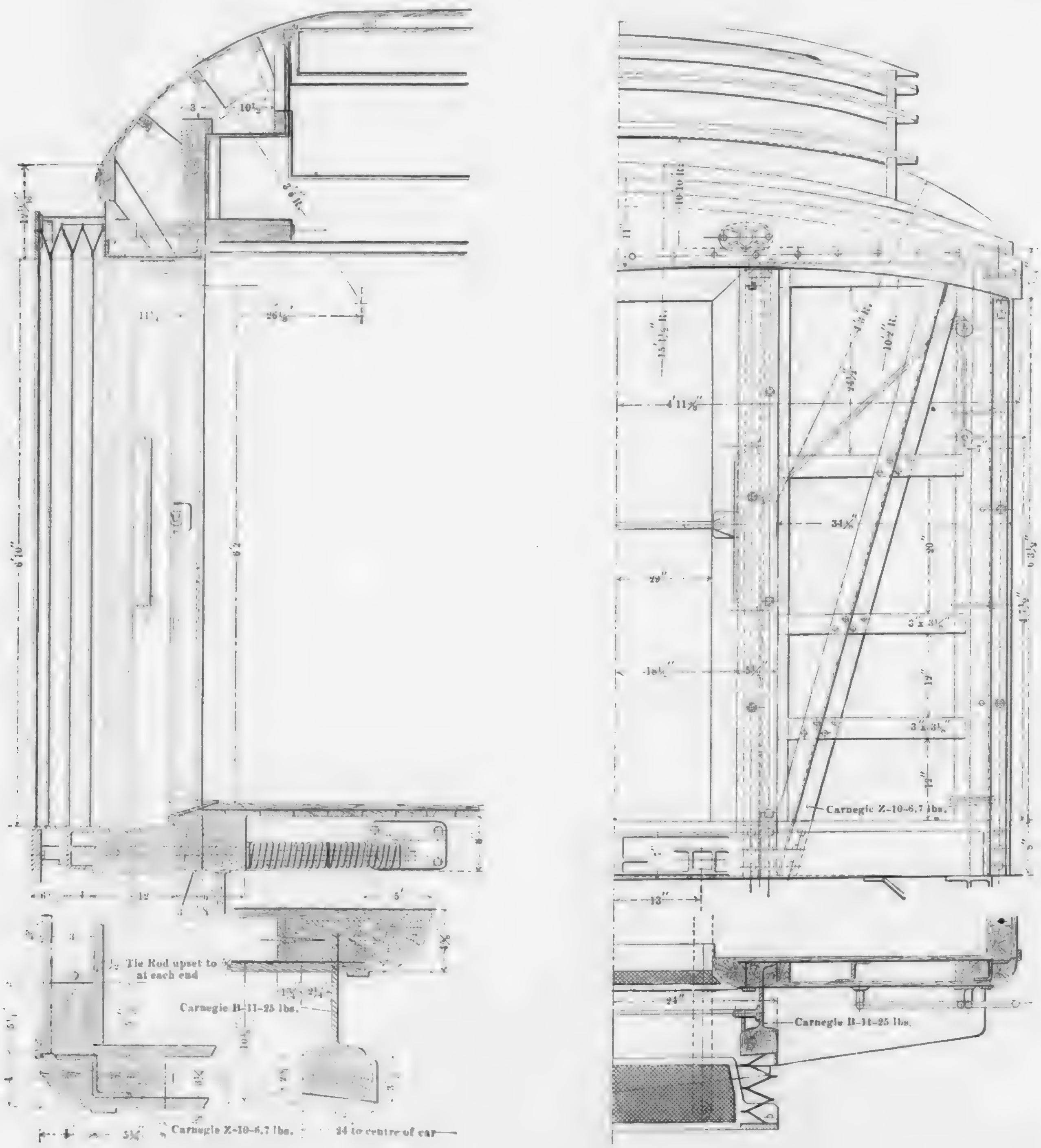
(To be continued.)

REINFORCEMENT OF POSTAL CARS.

PENNSYLVANIA RAILROAD.

In accordance with suggestions from the United States mail service officials, the end construction of postal cars on the Pennsylvania Railroad has been reinforced, as shown in these engravings. The reinforcement provided is even more effective than that suggested. Its purpose is to increase collision resistance.

In addition to the plates applied to the outside faces of the center sills and the inside faces of the side sills and the outside faces of the end sills, large rectangular castings are applied at the corners of the underframe; the end framing is reinforced in an entirely new way. The ¾ x 8-in. plate reinforcing the end sills receives the attachment of 10-in. 25 lb. I beams, forming posts for the vestibule opening. Across these I beams at the top is a horizontal plate with flanges o



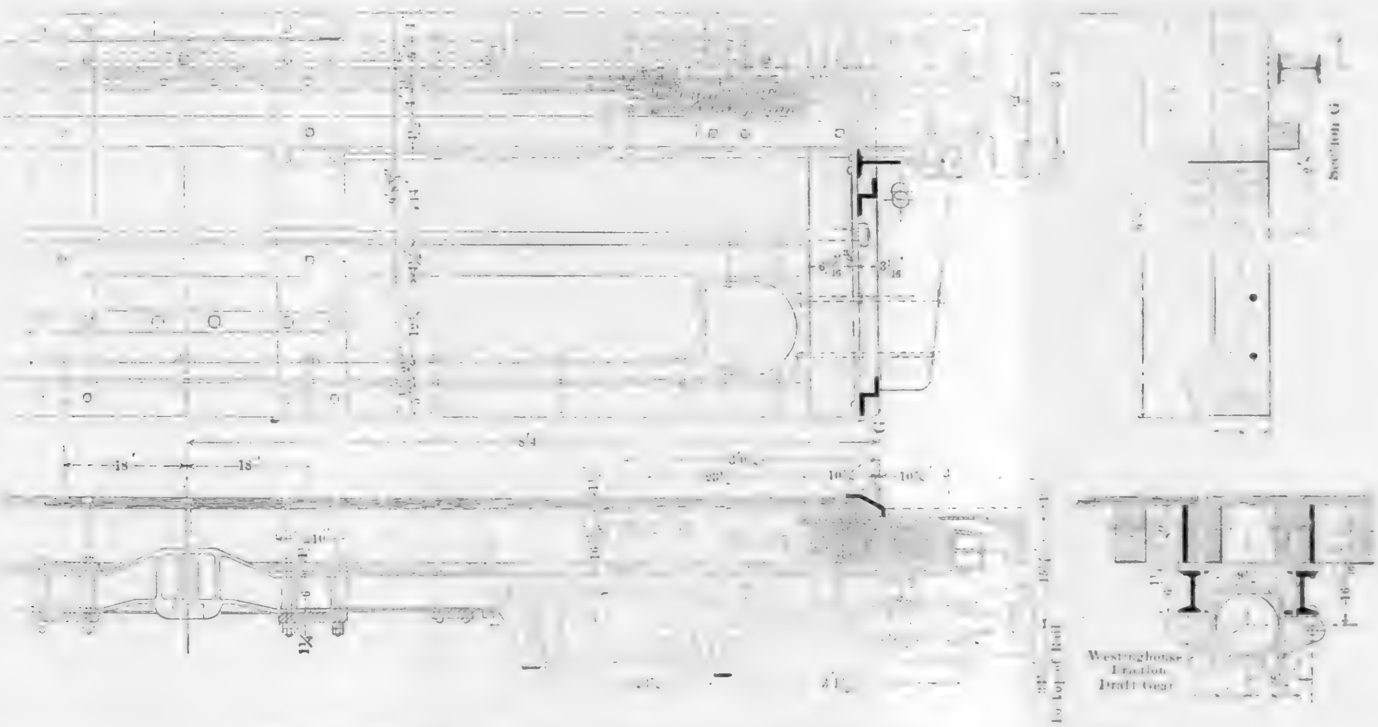
REINFORCEMENT OF END CONSTRUCTION OF POSTAL CARS.
PENNSYLVANIA RAILROAD.

...es, to which is connected a vertical plate across the end the car for a finish. The horizontal plate referred to in-...ases the collision strength of the upper portion of the ...tibule. In addition to the I beams, Z bars pass diagonally ...oss the end panels of the car, as indicated in the draw-... these being riveted to the end sill reinforcing plate at the ...ttom, and secured by angles to the horizontal plate at the ... Other Z bars are built in the corner posts of the car ...d are riveted to the end sill reinforcing plate at the bottom ...d the same horizontal plate at the top.

The draft sills of this car are 6-in. I beams extending 13 ...s. beyond the inner bolsters. These members receive plates ... their upper faces, at each side of both bolsters, and another ...rs between the two bolsters these plates being riveted to the upper flanges of the I beams. The drawing of the complete framing at the end of the car illustrates the application of the Westinghouse draft gear and the Standard Coupler Company's steel platform, which has been applied to some of these cars which are now in service.

The car itself is similar in its general features to previous construction on this road. Its interior arrangements, however, have been modified to suit recent requirements of the department to produce a combination car, which may be used either entirely for newspaper mail or first-class matter. The floor plan illustrates the large number of cases at one end of the car which are arranged as permanent fittings, but installed in such a way as not to interfere with the use of the car for ...aper mail when the racks are folded down from the wall.

The end reinforcement is built in accordance with patents ...sued to Mr. W. F. Kiesel, assistant mechanical engineer of the Pennsylvania Railroad.



REINFORCEMENT OF END CONSTRUCTION OF POSTAL CARS—PENNSYLVANIA RAILROAD.

Inasmuch as the Interstate Commerce Commission inspect-...rs are very closely watching automatic couplers for the break-...e of devices and coupler pin chains, which necessitate go-...g between the cars to make couplings, it seems advisable ... direct attention to the importance of one of the primary ...ments of draft rigging. That is the construction of the ...ging so that the coupler cannot travel beyond the standard ...lowance of motion of 1¾ ins., or 2 ins. at most. If the con-...uction is such that it cannot possibly allow more than that ...mount of motion to the coupler, it will be impossible for the ...hains to break under legitimate usage. Perhaps this feature ...f draft rigging has been overlooked. It should not be longer neglected.

A statement was printed last month giving credit to the shops of the Chicago & Northwestern Railway for the general repairs of 50 locomotives per month in a shop with but 21 pits. Attention has been called to the fact that record had already been made in this journal of general repairs at the rate of more than three engines per pit per month in other shops. In this connection it should be stated that at Altoona 3¼ engines per pit per month are turned out of the erecting shop. This, however, is a shop well equipped with crane service. The performance of the Chicago & Northwestern does not suffer in comparison, because the Chicago shops are not fitted with cranes, the only large crane at those works being in the boiler shop.

Air Openings Under Locomotive Grates.—There seems to be no doubt that there is a direct loss of heat when the air supply is inadequate and that a considerable saving may be accomplished by properly designing the damper openings. In an extract from the report of a committee before the Northwest Railway Club, which appeared on page 102 of our March number, the statement was made that the loss of heat when the air supply is not adequate sometimes reaches 25 per cent., and attention was drawn to the fact that damper openings on some of the newer types of locomotives were entirely too small.

For perfect combustion 8 lbs. of oxygen are required for every pound of hydrogen and 2 2-3 lbs. of oxygen for every pound of carbon. It has been suggested that by staying the firebox with hollow stay bolts with an inside diameter of ⅛ in., perfect combustion may be obtained. It is impossible to get sufficient air through the grates, and air in excessive volumes must not be admitted above the fire bed. The air which it would be possible to get through 1,000 or more hollow stay bolts with ⅛-in. holes might not be sufficient for perfect combustion, but it would furnish enough oxygen to pay for the hollow stay bolts several times over. As the air passes through these stay bolts the risk of burning them is decreased and the expansion of the bolt is reduced, and thus the liability of cracking the sheets is lessened. In addition the exhaust of the locomotive drawing the current of air through the hollow bolts keeps the holes open and affords a means for detecting breakage inside as well as outside of the firebox. The bolts are rolled hollow and the strength is thus increased and the bolt is more flexible.

ANGUS LOCOMOTIVE & CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

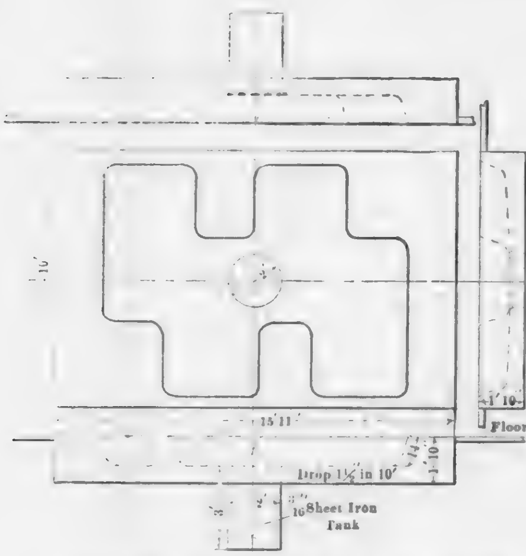
V.

(For previous article see page 75.)

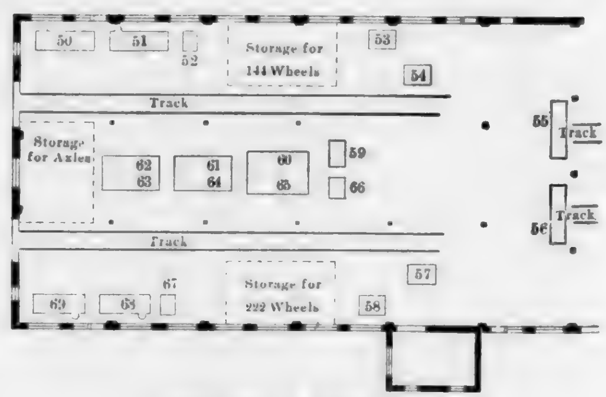
TRUCK SHOP.—This shop was shown in section in January, page 2. One of the accompanying engravings shows the west end with the location of machinery. The portion of the building not shown in this partial plan contains two tracks for passenger car trucks at the south side of the building and two for freight trucks at the north side, the work on freight trucks being facilitated by shallow pits outside the rails, enabling the men to get at the nuts on the side frames. Four men constitute a gang, and on the day of the writer's visit 28 trucks for 60,000-lb. cars had been completely assembled at 2:30 p. m. The rate of working approximates four trucks per hour. These trucks had diamond frames and Simplex bolsters. At the west end of the shop, material is brought to the machines on two short tracks reaching the axle lathes and wheel borers. The machinery is enumerated in the accompanying list. Each of the seven machines running during the writer's visit, was turning out twelve 4¼ by [illegible]-in. axles per day. The journals are also "rolled" in the lathes. The lathe foundations are of concrete, with an irregular depression, or basin, 14 ins. deep, having at the center a submerged sheet iron tank, 2 ft. in diameter by 3 ft. deep, to catch the drainage from the tools. The foundations themselves are 22 ins. deep. They are provided for all of the axle lathes in the shop. Storage for axles is provided near the axle lathes, and storage for wheels in the two spaces indicated; one is for 144 and the other for 222 wheels. The wheel presses are numbered 55 and 56 on this plan, and are located at the ends of the tracks, which reach to the opposite end of the building, these being the central two of the four tracks. The wheel presses are provided with Crosby recording gauges, in order to check the pressures used in pressing on the wheels. This shop is arranged for progressive work, the work advancing to completion at the east end, for delivery to the erecting shops. Every operation in the truck shop is on piecework.

INTERIOR OF TRUCK SHOP.

CAR MACHINE SHOP.—The plan of this building shows three longitudinal tracks, crossed by one transverse track with turntables. A section of the shop was shown in January, page 3. It provides for the machine work and bolt work, and is a manufacturing establishment. A very large amount of bolt



CONCRETE FOUNDATIONS FOR AXLE LATHES.

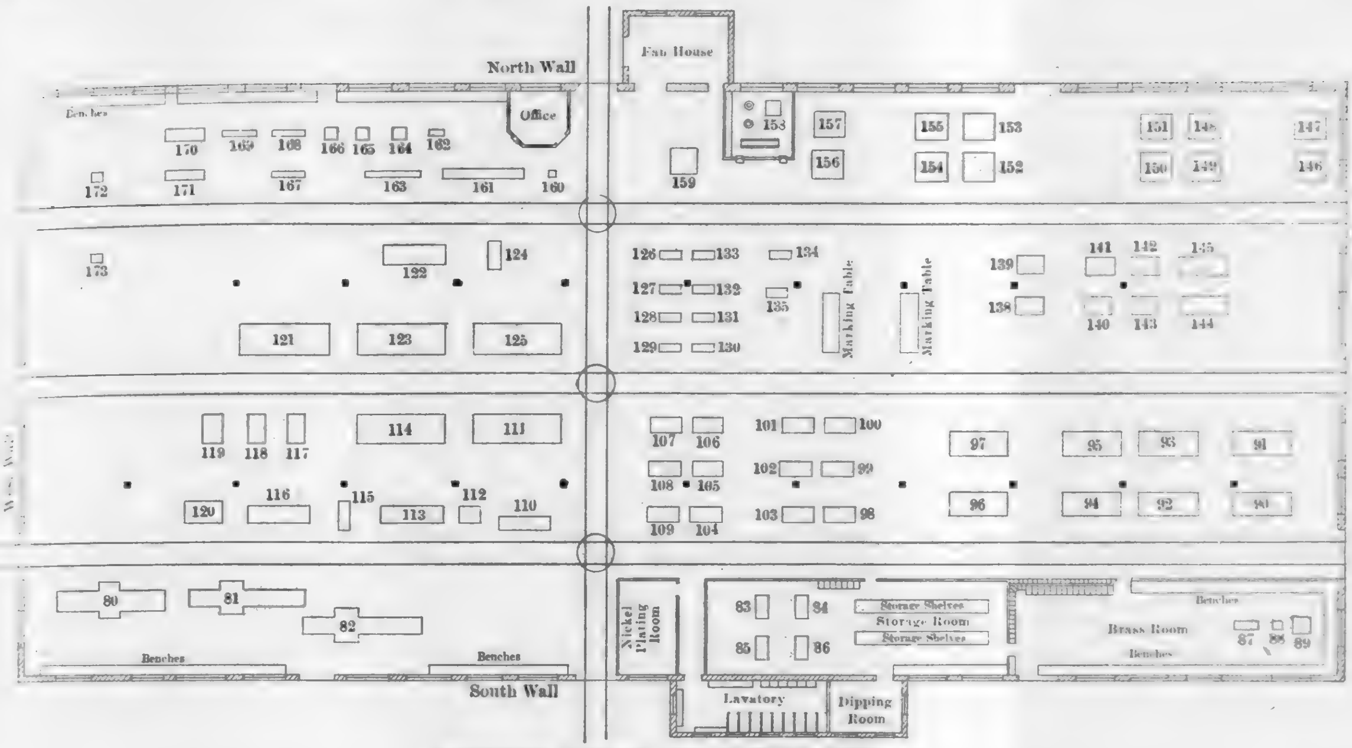


WEST END OF TRUCK SHOP.

LIST OF TOOLS.

TRUCK SHOP.

No.	Name and Maker.	Motor H. P.
50.	Axle lathe, J. Bertram & Sons	
51.	Axle lathe, J. Bertram & Sons	
52.	Water emery wheel	
53.	Car wheel borer, J. Bertram & Sons	1
54.	Car wheel borer, McKechnie & Bertram	
55.	Wheel, press, Hamilton Machine Tool Company	
56.	Wheel press, C. P. R.	
57.	Car wheel borer, Niles Tool Works	
58.	Car wheel borer, Niles Tool Works	
59.	5 ft. grindstone, Pond Machine Tool Company	
60.	Axle lathe, Niles Tool Works	
61.	Axle lathe, J. Bertram & Sons	
62.	Axle lathe, J. Bertram & Sons	
63.	Axle lathe, Niles Tool Works	
64.	Axlo lathe, J. Bertram & Sons	
65.	Axle lathe, Niles Tool Works	
66.	3 ft. wet emery wheel, Bridgeport Emery Wheel Company	
67.	Emery wheel	
68.	Axle lathe, McKechnie & Bertram	
69.	Axle lathe, J. Bertram & Sons	
—.	Wheel press	[illegible]



MACHINERY PLAN OF CAR MACHINE SHOP.

CAR MACHINE SHOP.

No.	Name and Maker.	Motor H.P.
80.	Double-headed planer, 48 ins. x 48 ins. x 12 ft., Mark Flather Planer Company	20
81.	Double-headed planer, 36 ins. x 36 ins. x 10 ft., McGregor & Gourley	7½
82.	Single headed planer, 30 ins. x 30 ins. x 10 ft., McGregor & Gourley	7½
83.	Double buffer	
84.	Double buffer	10
85.	Double buffer	
86.	Double buffer	
87.	¾-in. turret lathe, Bertram & Sons	
88.	16-in. sliding head drill press, Hamilton Machine Tool Company	5
89.	Miller, Smith & Coventry	
90.	6-spindle arch bar drill, Niles Tool Works	
91.	6-spindle arch bar drill, Bertram & Sons	
92.	6-spindle drill	
93.	6-spindle arch bar drill, Bertram & Sons	30
94.	6-spindle drill, Bertram & Sons	
95.	6-spindle drill, Bertram & Sons	
96.	6-spindle drill, Bertram & Sons	
97.	6-spindle drill, Bertram & Sons	
98.	32-in. vertical drill, Bertram & Sons	
99.	28-in. vertical drill, Cincinnati Machine Tool Company	
100.	25-in. vertical drill, Bertram & Sons	
101.	28-in. vertical drill, Cincinnati Machine Tool Company	
102.	28-in. vertical drill, Cincinnati Machine Tool Company	
103.	28-in. vertical drill, McGregor & Gourley	15
104.	26-in. vertical drill, Prentice Bros.	
105.	20-in. vertical drill, Prentiss	
106.	20-in. vertical drill	
107.	30-in vertical drill	
108.	26-in. vertical drill, Bertram & Sons	
109.	25-in. vertical drill, Bertram & Sons	
110.	Bolster drill	
111.	54-in. wheel lathe, Bertram & Sons	
112.	12-in. double emery wheel, C. P. R.	
	Journal lathe, McKechnie & Bertram	
	54-in. wheel lathe, Bertram & Sons	
	5 ft. x 8 in. grindstone, Pond Machine Tool Company	30
	24-in. double head traverse shaper, Cincinnati Shaper Company	
	14-in. shaper	
	18-in. shaper	
	24-in. shaper, Mark Flather	
	11-in. slotter, McKechnie & Bertram	
	42-in. wheel lathe, Pond Machine Tool Company	20
	Engine lathe, 15 ins. x 7 ft., Guelph Machine Tool Company	
	54-in. wheel lathe, Bertram & Sons	15
	5 ft. x 8 ins. grindstone, Pond Machine Tool Company	
	54-in. wheel lathe, Bertram & Sons	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	
	6-in. small vertical drill, C. P. R.	5
	8-in. small vertical drill, W. F. & T. Barnes Company	
	16-in. sliding head drill press, Hamilton Machine Tool Company	
	16-in. sliding head drill press, Hamilton Machine Tool Company	
	2-in. 6-spindle nut tapper, Acme Machine Company	
	2-in. 6-spindle nut tapper, Acme Machine Company	
	1½-in. 6-spindle nut tapper, Acme Machine Company	
	1-in. 6-spindle nut tapper, Acme Machine Company	
	1½-in. 4-spindle nut tapper	10
	1-in. 4-spindle nut tapper	
	1½-in. 6-spindle nut tapper	
	1½-in. 6-spindle nut tapper	
146.	1⅜-in. double bolt threader	
147.	1½-in. double bolt threader	
148.	1½-in. double bolt threader, A. R. Williams Machine Company	10
149.	1½-in. double bolt threader	
150.	1½-in. triple bolt threader, Bertram & Sons	
151.	1½-in. triple bolt threader, Bertram & Sons	
152.	1½-in. double bolt threader, National Machine Company	
153.	2-in. triple bolt threader, National Machine Company	
154.	1-in. double bolt threader	
155.	1½-in. double bolt threader, National Machine Company	
156.	2-in. triple bolt threader, Bertram & Sons	10
157.	2-in. triple bolt threader, Bertram & Sons	
158.	Drill grinder, Washburn Shops	
159.	Universal milling machine, No. 3, Cincinnati Milling Machine Company	
160.	Universal tool grinder, Cincinnati Milling Machine Company	
161.	Engine lathe, 30 ins. x 12 ft., Lodge & Shipley	
162.	8-in. vertical drill	
163.	Engine lathe, 24 ins. x 6 ft. 10 ins., Bertram & Sons	
164.	20-in. wet emery wheel, No. 3, Bridgeport Emery Wheel Company	
165.	8-in. vertical drill	
166.	Key seater, No. 1, W. P. Davis Machine Company	20
167.	Engine lathe, 20 ins. x 5 ft. 6 ins., Bertram & Sons	
168.	Engine lathe, 16 ins. x 7 ft. 3 ins., McGregor & Gourley	
169.	Engine lathe, 18 ins. x 6 ft. 3 ins., Lodge & Shipley	
170.	Engine lathe, 17 ins. x 5 ft.	
171.	Engine lathe, 15 ins. x 5 ft., Prentice Bros.	
172.	12-in. double emery wheel, Diamond Machine Company	
173.	12-in. double emery wheel, Diamond Machine Company	
	Car haul	10
	Car haul	10

and nut work is done here, the bolts being received from the car portion of the blacksmith shop in iron boxes, in which they are allowed to cool from the forging machines before reaching the machine shop. These boxes are handled by air hoists. The floor is clear of material. Bolts and nuts are made here for the entire system, including all but the finished bolts for the locomotive department. This shop turns out 20 pairs of passenger wheels per day, besides drilling brake levers, passenger platforms, and arch bars. Six-spindle Bertram drills each turn out 75 arch bars per day, the plan being followed, as far as possible, of concentrating the work of a given kind here for the entire system. This shop handles work as heavy as truck equalizers. The southeast corner of the building provides for the brass room, nickel-plating room and store room for the hardware for cars. This building is heated from a fan at the north wall. The location of the office and tool room are shown in the plan.

Freight Car Erecting Shop.—This building was shown in section on page 3. It is strictly a manufacturing department. It contains six tracks, with three air-hoist travelling cranes over each bay of three tracks at the east end, and is provided with a few special machines, such as circular saws. The west end is used for painting. This shop is also on a piecework basis throughout, and the pace of the workmen is

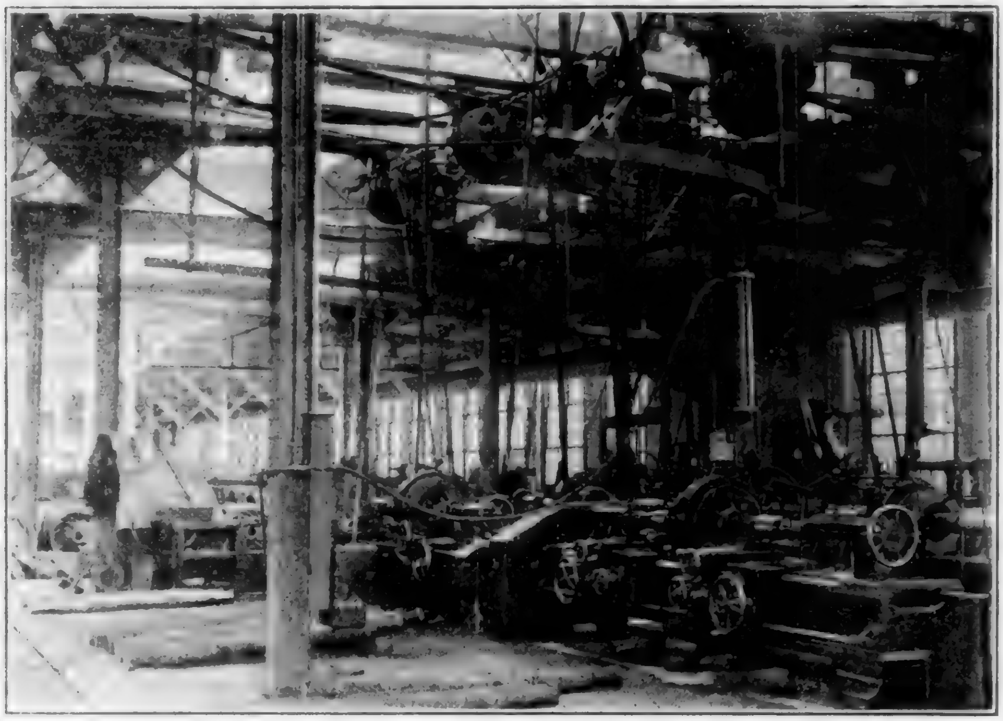
ANGUS LOCOMOTIVE & CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

V.

(*For previous article see page 75.*)

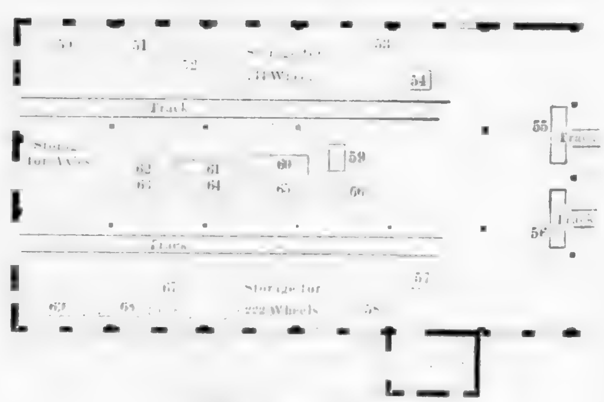
TRUCK SHOP.—This shop was shown in section in January, page 2. One of the accompanying engravings shows the west end with the location of machinery. The portion of the building not shown in this partial plan contains two ... for passenger car trucks at the south side of the build...g and two for freight trucks at the north side, the work on ... eight trucks being facilitated by shallow pits outside the rails, enabling the men to get at the nuts on the side frames. Four men constitute a gang, and on the day of the writer's visit 28 trucks for 60,000-lb. cars had been completely assembled at 2:30 p. m. The rate of working approximates four trucks per hour. These trucks had diamond frames and Simplex bolsters. At the west end of the shop, material is brought to the machines on two short tracks reaching the axle and wheel borers. The machinery is enumerated in t... companying list. Each of the seven machines running... ing the writer's visit, was turning out twelve 4¼ by ... axles per day. The journals are also "rolled" in the ... The lathe foundations are of concrete, with an irregul... pression, or basin, 14 ins. deep, having at the center ... merged sheet iron tank, 2 ft. in diameter by 3 ft. de... catch the drainage from the tools. The foundations ... selves are 22 ins. deep. They are provided for all of th... lathes in the shop. Storage for axles is provided nea... axle lathes, and storag... wheels in the two spaces ... cated; one is for 144 an... other for 222 wheels. The ... presses are numbered 55 a... on this plan, and are loca... the ends of the tracks, ... reach to the opposite end ... building, these being the c... two of the four tracks. The ... presses are provided with ... by recording gauges, in or... check the pressures use... pressing on the wheels. ... shop is arranged for progr... work, the work advancin... completion at the east en... delivery to the erecting s... Every operation in th... shop is on piecework.



INTERIOR OF TRUCK SHOP.

CAR MACHINE SHOP.—Th... of this building shows ... longitudinal tracks, crossed ... one transverse track with ... tables. A section of th... was shown in January, pag... It provides for the mac... work and bolt work, and is ... a manufacturing establishm... A very large amount of

CONCRETE FOUNDATIONS FOR AXLE LATHES.



WEST END OF TRUCK SHOP.

LIST OF TOOLS.

TRUCK SHOP.

No.	Name and Maker.	Motor
50.	Axle lathe, J. Bertram & Sons	
51.	Axle lathe, J. Bertram & Sons....	
52.	Water emery wheel	
53.	Car wheel borer, J. Bertram & Sons.......	
54.	Car wheel borer, McKechnie & Bertram.....	
55.	Wheel, press, Hamilton Machine Tool Company.	
56.	Wheel press, C. P. R........................	
57.	Car wheel borer, Niles Tool Works..............	
58.	Car wheel borer, Niles Tool Works..............	
59.	5 ft. grindstone, Pond Machine Tool Company	
60.	Axle lathe, Niles Tool Works	
61.	Axle lathe, J. Bertram & Sons.	
62.	Axle lathe, J. Bertram & Sons	
63.	Axle lathe, Niles Tool Works	
64.	Axle lathe, J. Bertram & Sons	
65.	Axle lathe, Niles Tool Works	
66.	3 ft. wet emery wheel, Bridgeport Emery Wheel Company	
67.	Emery wheel	
68.	Axle lathe, McKechnie & Bertram	
69.	Axle lathe, J. Bertram & Sons	
—.	Wheel press	

MACHINERY PLAN OF CAR MACHINE SHOP.

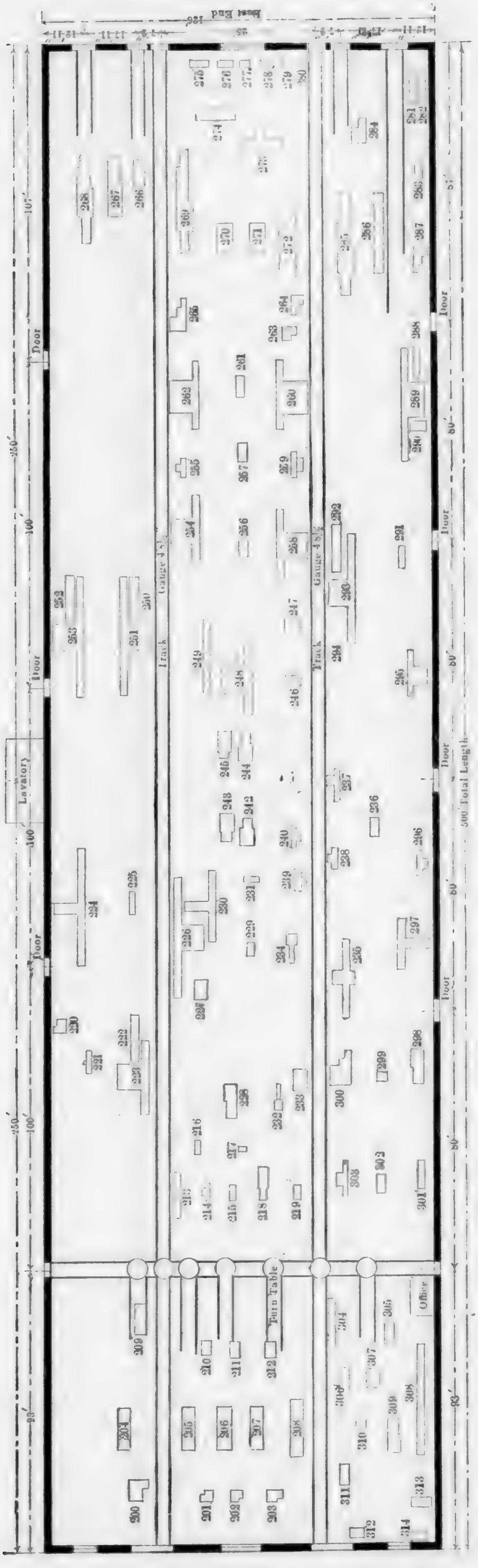
—CAR MACHINE SHOP

Name and Maker.	Motor H.P
ouble headed planer, 48 ins. x 48 ins. x 12 ft., Mark Flather Planer Company	20
uble headed planer, 36 ins. x 36 ins. x 10 ft., McGregor & Gourley	7½
uble headed planer, 30 ins. x 30 ins. x 10 ft., McGregor & Gourley	7½
uble buffer	
uble buffer	10
uble buffer	
uble buffer	
in. turret lathe, Bertram & Sons	
in. sliding head drill press, Hamilton Machine Tool Company	5
r, Smith & Coventry	
dle arch bar drill, Niles Tool Works	
dle arch bar drill, Bertram & Sons	
pindle drill	
pindle arch bar drill, Bertram & Sons	30
pindle drill, Bertram & Sons	
pindle drill, Bertram & Sons	
pindle drill, Bertram & Sons	
pindle drill, Bertram & Sons	
vertical drill, Bertram & Sons	
n. vertical drill, Cincinnati Machine Tool Company	
in. vertical drill, Bertram & Sons	
-in. vertical drill, Cincinnati Machine Tool Company	
-in. vertical drill, Cincinnati Machine Tool Company	
in. vertical drill, McGregor & Gourley	15
6-in. vertical drill, Prentice Bros.	
-in. vertical drill, Prentiss	
n. vertical drill	
vertical drill	
n. vertical drill, Bertram & Sons	
in. vertical drill, Bertram & Sons	
-ter drill	
wheel lathe, Bertram & Sons	
in. double emery wheel, C. P. R.	
tual lathe, McKechnie & Bertram	
in. wheel lathe, Bertram & Sons	
ft. x 8 in. grindstone, Pond Machine Tool Company	
in. double head traverse shaper, Cincinnati Shaper Company	30
in. shaper	
in. shaper	
in. shaper, Mark Flather	
n. slotter, McKechnie & Bertram	
in. wheel lathe, Pond Machine Tool Company	20
ngine lathe, 15 ins. x 7 ft., Guelph Machine Tool Company	
in. wheel lathe, Bertram & Sons	15
ft. x 8 ins. grindstone, Pond Machine Tool Company	
in. wheel lathe, Bertram & Sons	
in. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	
n. small vertical drill, C. P. R.	5
n. small vertical drill, W. F. & T. Barnes Company	
in. sliding head drill press, Hamilton Machine Tool Company	
sliding head drill press, Hamilton Machine Tool Company	
6-spindle nut tapper, Acme Machine Company	
n. 6-spindle nut tapper, Acme Machine Company	
-in. 6-spindle nut tapper, Acme Machine Company	
n. 6-spindle nut tapper, Acme Machine Company	
-in. 4-spindle nut tapper	10
in. 4-spindle nut tapper	
-in. 6-spindle nut tapper	
-in. 6-spindle nut tapper	

No	Name and Maker.
146.	1⅝-in. double bolt threader
147.	1½-in. double bolt threader
148.	1½-in. double bolt threader, A. R. W... pany
149.	1½-in. double bolt threader
150.	1½-in. triple bolt threader, Bertram & Son
151.	1½-in. triple bolt threader, Bertram & Son
152.	1½-in. double bolt threader, National Machin
153.	2-in. triple bolt threader, National Machine Co
154.	1 in. double bolt threader
155.	1½-in. double bolt threader, National Mac
156.	2-in. triple bolt threader, Bertram & Son
157.	2-in. triple bolt threader, Bertram & So
158.	Drill grinder, Washburn Shops
159.	Universal milling machine, N... chine Company
160.	Universal tool grinder, Cincinnati Milling M
161.	Engine lathe, 30 ins. x 12 ft., Lodge & Shi
162.	8-in. vertical drill
163.	Engine lathe, 24 ins. x 6 ft. 10 ins., Bertram
164.	20 in. wet emery wheel, No. 2, Bridgeport E... Company
165.	8-in. vertical drill
166.	Key seater, No. 1, W. P. Davis Machine C
167.	Engine lathe, 20 ins. x 5 ft. 6 ins., Bertram & So
168.	Engine lathe, 16 ins. x 7 ft. 2 ins., McGregor & G
169.	Engine lathe, 18 ins. x 6 ft. 3 ins., Lod
170.	Engine lathe, 17 ins. x 5 ft.
171.	Engine lathe, 15 ins. x 5 ft., Prentice B
172.	12-in. double emery wheel, Diamond M
173.	12-in. double emery wheel, Diamond M
	Car haul
	Car haul

and nut work is done here, the bolts being received from the car portion of the blacksmith shop in iron boxes, in which they are allowed to cool from the forging machines before reaching the machine shop. These boxes are handled ... hoists. The floor is clear of material. Bolts and nuts are made here for the entire system, including all but the finished bolts for the locomotive department. This shop ... out 20 pairs of passenger wheels per day, besides drilling brake levers, passenger platforms, and arch bars. Six-spindle Bertram drills each turn out 75 arch bars per day, the plan being followed, as far as possible, of concentrating the work of a given kind here for the entire system. This shop handles work as heavy as truck equalizers. The southeast corner of the building provides for the brass room, nickel-plating room and store room for the hardware for cars. This building is heated from a fan at the north wall. The location of the office and tool room are shown in the plan.

FREIGHT CAR ERECTING SHOP.—This building was shown in section on page 3. It is strictly a manufacturing department. It contains six tracks, with three air-hoist travelling cranes over each bay of three tracks at the east end, and is provided with a few special machines, such as circular saws. The west end is used for painting. This shop is also on a piecework basis throughout, and the pace of the workmen is



ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, AT MONTREAL—MACHINERY PLAN OF PLANING MILL.

PLANING MILL.

No.	Name and Maker.	Motor H. P.
200.	No. 1 Greenlee Auto cut-off saw	
201.	No. 1 Greenlee Auto cut-off saw	[illegible]
202.	No. 1 Greenlee Auto cut-off saw	
203.	No. 1 Greenlee Auto cut-off saw	
204.	No. 46 Berlin planer and double matcher	4[illegible]
205.	No. 46 Berlin planer and double matcher	4[illegible]
206.	No. 44 Berlin planer and double matcher	3[illegible]
207.	Bertram large 4-headed matcher and dimension planer, 6 ins. x 24 ins.	[illegible]
208.	Fay large 4-headed matcher, 6 ins. x 24 ins.	2[illegible]
209.	No. 1½ Greenlee S. F. rip saw set with collar 4 inches long	
210.	No. 1½ Greenlee S. F. rip saw set with collar 4 inches long	[illegible]
211.	No. 1½ Greenlee S. F. rip saw set with collar 4 inches long	
212.	Greenlee S. F. rip saw, 30-in saw	
213.	C. P. R. swing saw, 18-in. saw	
214.	No. 98 Woods & Co. improved jointing and facing machine or buzz planer	[illegible]
215.	No. 3 McGregor, Gourley & Co. self-feed rip saw	
216.	McGregor, Gourley & Co. new improved rip saw, 30-in. saw	
217.	Bertram horizontal borer, 12 ins. thick, 3⅛-in. hole	
218.	McKechnie & Bertram large horizontal tenoning machine, 9 in.	1[illegible]
219.	No. 3 McGregor, Gourley & Co. band saw	
220.	No. 5 McGregor, Gourley & Co. large band resaw	1[illegible]
221.	Vertical car sill end tenoning machine, 9 ins. x 12 ins. thick, McKechnie & Bertram	2[illegible]
222.	Swing saw, 18-in., C. P. R.	
223.	Greenlee extra range heavy car boring machine, 12 ft. table	
224.	No. 3 Greenlee extra range heavy Auto car gainer, 40-ft. table	1[illegible]
225.	No. 4 Greenlee Auto vertical car sill tenoner	1[illegible]
226.	No. 14 Greenlee std. heavy vertical hollow chisel mortiser, 40-ft. table	2[illegible]
227.	No. 58 Fay band saw	
228.	No. 00 McGregor, Gourley & Co. outside moulding machine	10
229.	No. 00 Fay Patent band saw, 36-in. wheels	
230.	Bertram horizontal gainer, 14 ins. thick x 24 ins. wide	20
231.	Bertram single horizontal boring machine, 2-in.	
232.	McGregor, Gourley & Co. double-headed shaper	10
233.	Greenlee 3-spindle medium heavy vertical boring machine	
234.	McGregor, Gourley & Co. double-headed shaper	20
235.	Bertram hollow chisel mortiser, 2½-in.	
236.	McGregor, Gourley & Co. rip saw	
237.	Fay vertical gainer, checks 2 ins. deep by 3 ins. wide	
238.	Fay 3-spindle boring machine, bores 2½ ins., 12 ins. deep	40
239.	Greenlee std. heavy 3-spindle vertical car boring machine	
240.	Greenlee heavy single-spindle horizontal boring machine	
242.	McKechnie & Bertram large horizontal 9-in. tenoning machine	
243.	No. 5 Greenlee heavy Universal horizontal car tenoner	40
244.	McKechnie & Bertram large horizontal tenoning machine	
245.	No. 5 Greenlee heavy Univeral horizontal car tenoner	
246.	No. 6 Fay car 72-in. mortiser and borer	10
247.	No. 6. Fay car 72-in. mortiser and borer	
248.	No. 14 Greenlee std. heavy vertical hollow chisel mortiser 12-in. table	
249.	No. 3 Greenlee extra range heavy auto car gainer	15
250.	Swing saw, 18-in., C. P. R.	20
251.	Greenlee extra range heavy car boring machine, 40-ft. table	
252.	Swing saw, 18-in., C. P. R.	20
253.	Greenlee extra range heavy car boring machine, 40-ft. table	
254.	Bertram horizontal gainer, gains timber 2 ins. x 3 ins. wide, 16 ins. across	15
255.	Greenlee std. heavy 3-spindle vertical car boring machine	
256.	No. 2 Fay improved std. ripping saw	15
257.	No. 2 Fay improved ripping saw	15
258.	Greenlee 5-spindle boring machine	20
259.	Greenlee std. heavy 3-spindle vertical car boring machine	
260.	No. 14 Greenlee std. heavy vertical hollow chisel mortiser	15
261.	No. 3 Fay large size car ripping saw	20
262.	Greenlee extra range heavy car boring machine	20
263.	No. 2 Greenlee Auto cut-off saw	
264.	No. 5 Greenlee vertical heavy Auto cut-off saw, to cut timber up to 14 ins. square	15
265.	No. 5 Greenlee vertical heavy Auto cut-off saw, to cut timber up to 14 ins. square	15
266.	No. 3 Greenlee rip saw, takes 30-in. saw and rips 19 ins. wide	20
267.	No. 6 Fay outside moulder	30
268.	No. 8 Berlin planer and sizer	50
269.	No. 8 Berlin planer and sizer	50
270.	No. 3 Greenlee rip saw	20
271.	No. 3 Greenlee rip saw	20
272.	No. 24 Berlin planer, matcher	30
273.	Fay variety wood worker or buzz planer	5
274.	McGregor, Gourley & Co. Auto band saw filer	
275.	No. 1 Fay Auto knife grinder	
276.	Knife grinder	
277.	C. P. R. emery wheel	
278.	Egan Auto knife grinder	10
279.	Emery wheel	
280.	Circular saw sharpener	
281.	Pond portable grindstone, 72 ins.	
282.	Pond portable grindstone, 72 ins.	
283.	Bertram large rip saw, 36 ins. saw	15
284.	No. 6 Greenlee vertical heavy Auto cut-off saw	15
285.	Fay 4-head dimension planer, planes 12 ins. deep, 16 ins. wide, 4 sides	40
286.	Cant Gourley 4-headed matcher and dimension planer, planes 6 ins. thick, 24 ins. wide	20
287.	Bertram large butting saw, 36 ins. saw	15
288.	Iron frame swing saw, 18 ins. saw, C. P. R.	
289.	Greenlee 5-spindle boring machine	20
290.	Bertram horizontal gainer, gains 2 ins. deep, 3 ins. wide, 16 ins. across	
291.	McKechnie & Bertram vertical end tenoning machine, 9 ins. x 12 ins.	30
292.	Iron frame swing saw, 18 ins. saw, C. P. R.	
293.	Greenlee big hollow chisel sill mortiser machine, 8 in. deep, 2 in. chisel	15
294.	3 spindle boring machine, C. P. R.	
295.	Hollow chisel mortising and boring machine, C. P. R.	15
296.	Greenlee 3-spindle medium heavy vertical boring machine	15
297.	Gainer, gains 2 ins. thick, 3 ins. wide, 16 ins. face Fay & Egan	
298.	McGregor, Gourley & Co. 4-headed outside moulder	20

Name and Maker.	Motor H.P.
No. 1½ McGregor, Gourley & Co. shaping machine	15
No. 3 Greenlee vertical heavy Auto cut-off saw and gainer	
McGregor Gourley & Co. dimension saw	
McGregor, Gourley & Co. band saw, 36 in. wheel	15
Fay auto vertical cut-off saw	
McGregor, Gourley & Co. swing saw, 32 in. saw	
Rip saw, 30 in. saw, C. P. R.	
McGregor, Gourley & Co. buzz planer	
Cowan & Co. small rip saw, 14 in. saw	12
McGregor, Gourley & Co. dimension planer, planes 6 ins. x 24 ins.	
McGregor, Gourley & Co. 4-headed outside moulder	
Bertram surface planer, planes 6 ins. thick x 24 ins. wide	
McGregor, Gourley & Co. small rip saw	30
Chain saw mortiser	
Small sash door mortiser	
McKechnie & Bertram light tenoning machine tenons for sash and doors	10

remarkable one for any shop. At the time of the writer's it sixteen 60,000-lb. box cars were being turned out per day. the west end of the building motor-driven winches are cated, for hauling out the cars completed each day. This building, like all the rest, is well provided with automatic sprinklers for fire protection.

PLANING MILL.—This building is 500 ft. long by 125 ft. wide, and the machinery is divided into two parts; one for preparing material for building new freight cars, and the other for preparing material for building new passenger cars, store orders and repair work. These two departments are entirely separate. All the heavy timber comes in at the east end of the mill (at the right in the floor plan), where there are placed for the freight car department two large timber planers, one inside moulder, two large self-feed rip saws. The north side of the mill (upper part of the plan) is used exclusively for the sills and long timbers, and after the sills have been run through the planer they are butted off and then passed over to the end tenoning machine, and then to two five-spindle vertical boring machines with 40-ft. travelling tables, and from this machine to a gaining machine, and from the gaining machine they are placed on a lorry and run into the erecting shop. On this same side there is also a hollow chisel mortising machine with a 40-ft. travelling table for mortising plates and ridge poles.

(1) EXTERIOR PORTIONS OF SHAVINGS EXHAUST SYSTEM. (2) TENONING MACHINE IN PLANING MILL. (3) ONE OF THE PLANERS, PLANING MILL. (4) SHAVINGS EXHAUST APPLIED TO A GAINING MACHINE.

The center of the mill is used for getting out short material for new freight cars, such as end sills, posts and carlines, and after they are run through the planers they are next passed to large butting saws, and then to mortising and boring machines, as the case may be, and when finished the pieces are placed upon roller-bearing lorries and transferred into the erecting shop.

Material for passenger cars, store orders and repair work is handled in the same manner as described for the freight cars. It is taken in at the east end of the mill, where there are two large timber planers and one large matcher or sizer, and then passed on to boring, mortising and graining machines until finished.

At the west end of the mill there is a cross track with turntables, where all lighter material is brought in and laid down to the planers and matchers. For the freight car side there are two large double matchers and planers and one single matcher. For the passenger car side there are two matchers and planers, and at the rear of all these planers there is an automatic cut-off saw for each planer to cut off sheathing, etc., after it has been run through. In the west end of the shop there are also two sets of machinery for getting out the lighter work for the interior finish and repairs to passenger cars.

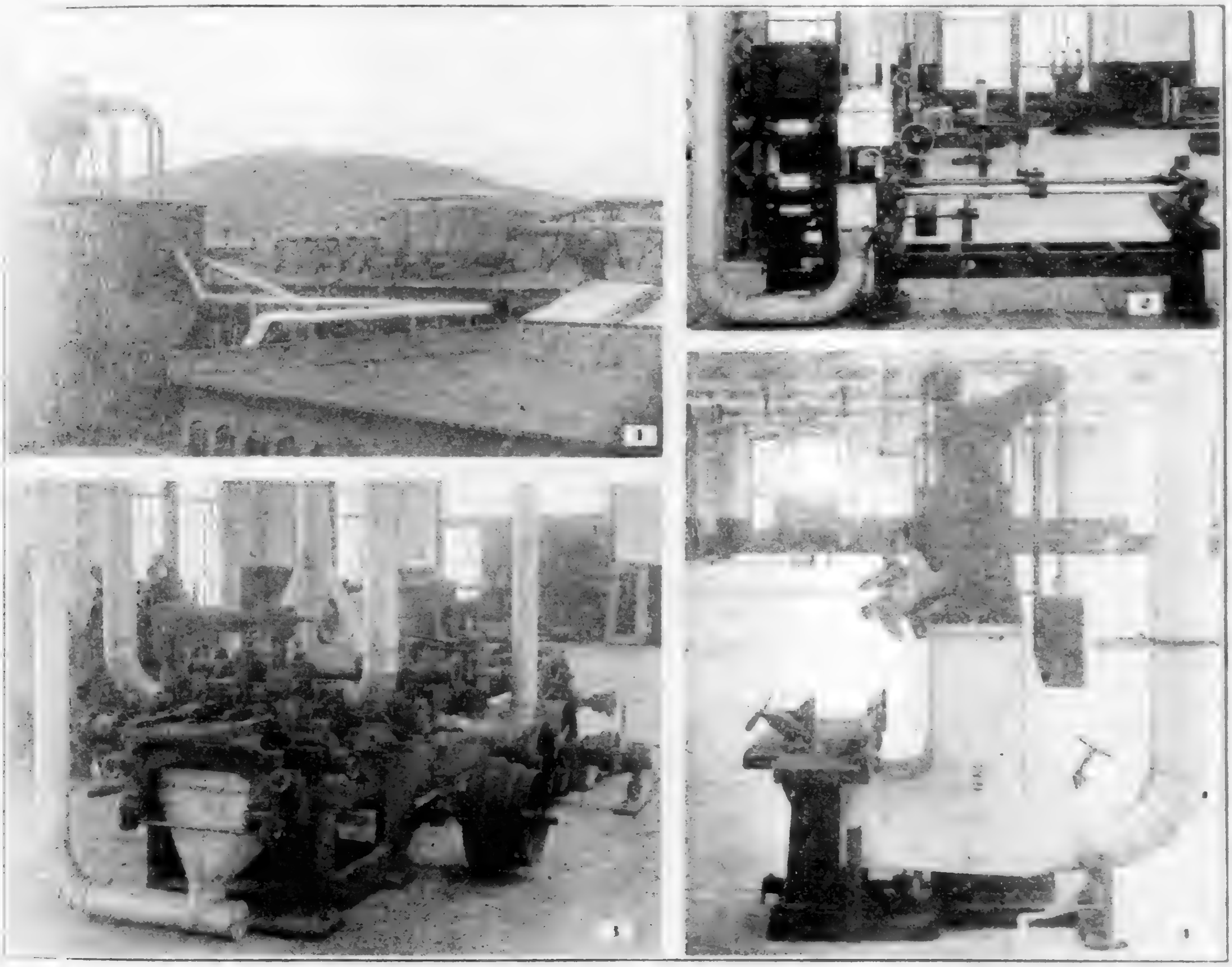
All the machines in this mill are motor-driven; the larger machines by independent motors and the lighter machines in

PLANING MILL.

No.	Name and Maker	Motor
	No. 1 Greenlee Auto cut-off saw	
	No. 1 Greenlee Auto cut-off saw	
202.	No. 1 Greenlee Auto cut-off saw	
	No. 1 Greenlee Auto cut-off saw	
204.	No. 16 Berlin planer and double matcher	
	No. 16 Berlin planer and double matcher	
	No. 44 Berlin planer and double matcher	
	Bertram large 4-headed matcher and dimension planer, 6 ins. x 24 ins.	
	Fay large 4-headed matcher, 6 ins. x 24 ins.	
209.	No. $1\frac{1}{2}$ Greenlee S. F. rip saw set with collar 4 inches long	
210.	No. $1\frac{1}{2}$ Greenlee S. F. rip saw set with collar 4 inches long	
211.	No. $1\frac{1}{2}$ Greenlee S. F. rip saw set with collar 4 inches long	
212.	Greenlee S. F. rip saw, 30-in saw	
213.	C. P. R. swing saw, 18-in. saw	
214.	No. 98 Woods & Co. improved jointing and facing machine or buzz planer	
	No. 3 McGregor, Gourley & Co. self-feed rip saw	
216.	McGregor, Gourley & Co. new improved rip saw, 30-in. saw	
217.	Bertram horizontal borer, 12 ins. thick, $3\frac{1}{8}$-in. hole	
218.	McKechnie & Bertram large horizontal tenoning machine,	
219.	No. 3 McGregor, Gourley & Co. band saw	
	No. 5 McGregor, Gourley & Co. large band resaw	
221	Vertical car sill end tenoning machine, 9 ins. x 12 ins. thick, McKechnie & Bertram	
	Swing saw, 18-in., C. P. R.	
	Greenlee extra range heavy car boring machine, 12 ft. table	
	No. 3 Greenlee extra range heavy Auto car gainer, 40-ft. table	
	No. 4 Greenlee Auto vertical car sill tenoner	
226.	No. 14 Greenlee std. heavy vertical hollow chisel mortiser, 40-ft. table	
	No. 58 Fay band saw	
228.	No. 00 McGregor, Gourley & Co. outside moulding machine	
	No. 00 Fay Patent band saw, 36-in. wheels	
	Bertram horizontal gainer, 14 ins. thick x 24 ins. wide	
	Bertram single horizontal boring machine, 2-in.	
	McGregor, Gourley & Co. double-headed shaper	
	Greenlee 3-spindle medium heavy vertical boring machine	
	McGregor, Gourley & Co. double-headed shaper	
	Bertram hollow chisel mortiser, $2\frac{1}{2}$-in.	
	McGregor, Gourley & Co. rip saw	
	Fay vertical gainer, checks 2 ins. deep by 3 ins. wide	
	Fay 3-spindle boring machine, bores $2\frac{1}{2}$ ins., 12 ins. deep	
	Greenlee std. heavy 3-spindle vertical car boring machine	
	Greenlee heavy single-spindle horizontal boring machine	
242.	McKechnie & Bertram large horizontal 9-in. tenoning machine	
	No. 5 Greenlee heavy Universal horizontal car tenoner	
	McKechnie & Bertram large horizontal tenoning machine	
	No. 5 Greenlee heavy Univeral horizontal car tenoner	
	No. 6 Fay car 72-in. mortiser and borer	
	No. 6 Fay car 72-in. mortiser and borer	
	No. 14 Greenlee std. heavy vertical hollow chisel mortiser 12-in. table	
	No. 3 Greenlee extra range heavy auto car gainer	
	...aw, 18-in., C. P. R.	
	... extra range heavy car boring machine, 40-ft. table	
	Swing saw, 18-in., C. P. R.	
	Greenlee extra range heavy car boring machine, 40-ft. table	
	...n horizontal gainer, gains timber 2 ins. x 3 ins. wide,	
	Greenlee std. heavy 3-spindle vertical car boring machine	
	No. ... Fay improved std. ripping saw	15
	... Fay improved ripping saw	
	...pindle boring machine	
	...l. heavy 3-spindle vertical car boring machine	
	...4 Greenlee std. heavy vertical hollow chisel mortiser	
	...3 Fay large size car ripping saw	
	... heavy car boring machine	
	...Auto cut-off saw	
	... Greenlee vertical heavy Auto cut-off saw, to cut timber up to 14 ins. square	
	No. 5 Greenlee vertical heavy Auto cut-off saw, to cut timber up to 14 ins. square	
	No. 3 Greenlee rip saw, takes 30-in. saw and rips 19 ins. wide	
	No. ... outside moulder	
	...r and sizer	
	... and sizer	
	No. ...	
	No. ... rip saw	
	No. ... planer, matcher	
	Fay ... worker or buzz planer	
	... Co. Auto band saw filer	
	... grinder	
	Knife grinder	
	C. P. R. emery wheel	
	Egan Auto knife gr...	
	Emery wheel	
	Circular saw sharpener	
	Pond portable grindstone, ... ins.	
	Pond portable grindstone, ... in.	
	Bertra... ...ip saw, 36 ins. saw	
	No. 6 Greenlee vertical heavy Auto cut-off saw	
	Fay 4-head dimension planer, planes 12 ins. deep, 16 ins. wide, 4 sides	
	Cant Gourley 4-headed matcher and dimension planer, planes 6 ins. thick, 24 ins. wide	
	Bertram large butting saw, 36 ins. saw	
	Iron frame swing saw, 18 ins. saw, C. P. R.	
	Greenlee 5-spindle boring machine	
	Bertram horizontal gainer, gains 2 ins. deep, 3 ins. wide, 16	
	... Bertram vertical end tenoning machine, 9 ins.	
292	Iron frame swing saw, 18 ins. saw, C. P. R.	
	Greenlee big hollow chisel sill mortiser machine, 8 in. deep, 2 in. chisel	
294	3-spindle boring machine, C. P. R.	
	Hollow chisel mortising and boring machine, C. P. R.	
	Greenlee 3-spindle medium heavy vertical boring machine	
	Gainer, gains 2 ins. thick, 3 ins. wide, 16 ins. face Fay & Egan	15
	McGregor, Gourley & Co. 4-headed outside moulder	

Name and Maker.	Motor H.P
... 1½ McGregor, Gourley & Co. shaping machine	15
...3 Greenlee vertical heavy Auto cut-off saw and gainer	
...regor Gourley & Co. dimension saw	15
...regor, Gourley & Co. band saw, 36 in. wheel	
...uto vertical cut-off saw	
...Gregor, Gourley & Co. swing saw, 32 in. saw	
...aw, 30 in. saw, C. P. R.	
...Gregor, Gourley & Co. buzz planer	
...wan & Co. small rip saw, 14 in. saw	12
...cGregor, Gourley & Co. dimension planer, planes 6 ins. ...	
...Gregor, Gourley & Co. 4-headed outside moulder	
...ram surface planer, planes 6 ins. thick x 24 ins. wide	30
...regor, Gourley & Co. small rip saw	
...n saw mortiser	
...all sash door mortiser	10
...Kechnie & Bertram light tenoning machine tenons for sash and doors	

...markable one for any shop. At the time of the writer's ... sixteen 60,000-lb. box cars were being turned out per day. ...e west end of the building motor-driven winches are ...d for hauling out the cars completed each day. This ...



(1) EXTERIOR PORTIONS OF SHAVINGS EXHAUST SYSTEM. (2) TENONING MACHINE IN PLANING MILL. (3) ONE OF THE PLANERS, PLANING MILL. (4) SHAVINGS EXHAUST APPLIED TO A GAINING MACHINE.

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The center of the mill is used for getting out short material for new freight cars, such as end sills, [illegible] etc. after they are run through the planers they are next passed to large butting saws, and then to mortising and boring machines, as the case may be, and when finished the pieces are placed upon roller-bearing lorries and transferred into the erecting shop.

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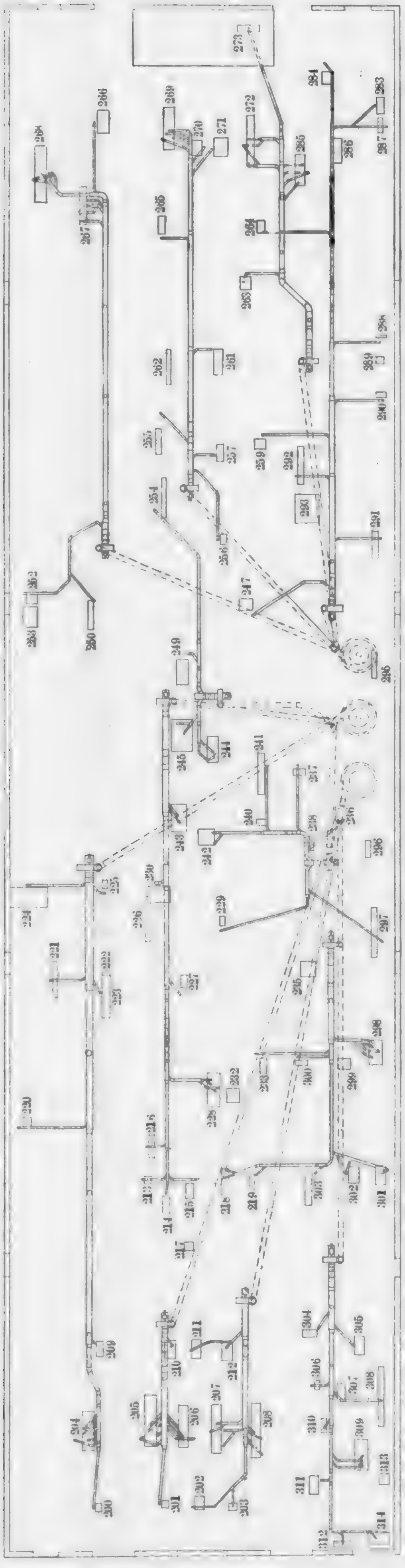


PLAN OF SHAVINGS EXHAUST SYSTEM APPLIED TO PLANING MILL.

TESTS MADE ON MOTORS DRIVING FANS IN PLANING MILL, CABI
SHOP, AND SHAVINGS TOWER.

(*Speeds observed with an Indicating Tachcometer.*)

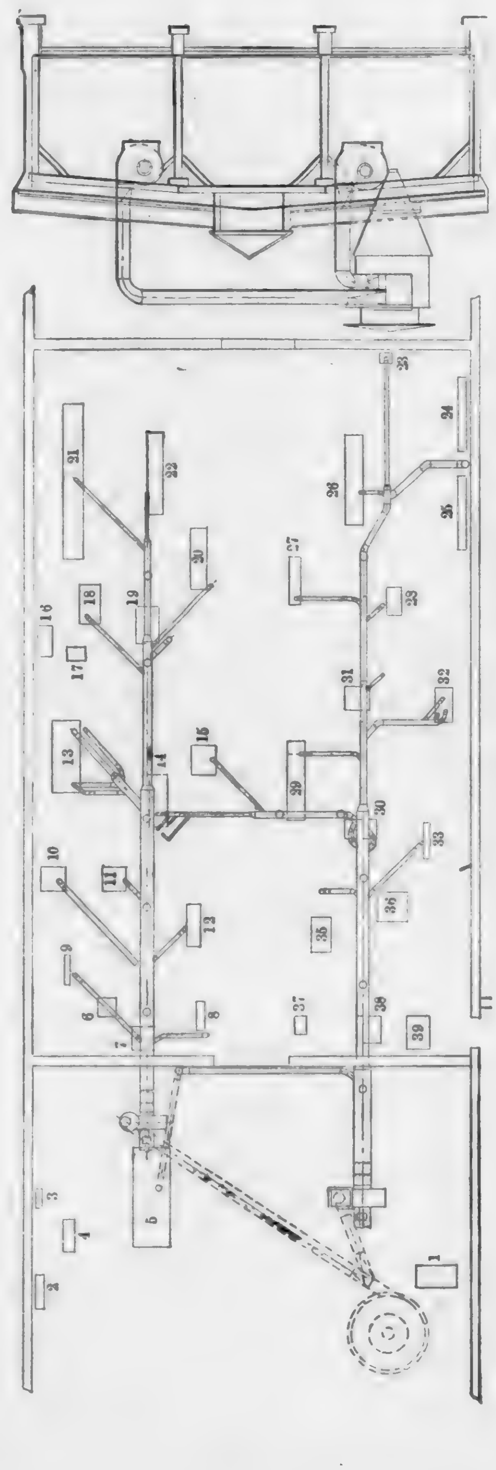
Fan.	Vacuum — At fan. inches.	Vacuum — At end of pipe. inches.	Speed of fan—actual.	Speed of motor—actual.	Input. h.p.	Rated of mot
A	4 13-16	3 1-16	820	840	30.1	30
B	6¼	5⅝	830	890	30.3	30
C	4⅞	3⅝	815	860	23.2	30
D	4⅝	3¼	720	860	19.4	30
E	5	2½	880	885	18.1	20
F	4 11-16	8	725	900	19.6	30
G	5⅝	3 1-16	805	880	26.6	30
H	4⅞	3⅞	810	900	26.7	30
I	5⅛	2⅞	880	880	13.9	20
J	4⅝	3 1-16	820	880	19.8	30
K	5⅛	3¾	805	885	30.0	30
L	4½	3¾	800	875	20.5	30
M	5	4⅞	760	890	13.1	20
N	5¼	4 3-16	665	890	25.8	30
O	4½	3	800	514	27.4	30
P	11½	4¼	1,720	880	26.4	30
Q	7¾	7	1,100	900	22.5	20

Remarks.

Fans A to L are in planing mill; M and N in cabinet shop, and O to in the shavings tower.

Shutting off two inlets on pipes connected to fan K made a decrea of 6 h.p. in motor input.

20-h.p. motor was found to take ½ h.p. running light with belt off, an 30-h.p. motor, 1.9 h.p.



PLAN OF SHAVINGS EXHAUST SYSTEM APPLIED TO THE CABINET SHOP.

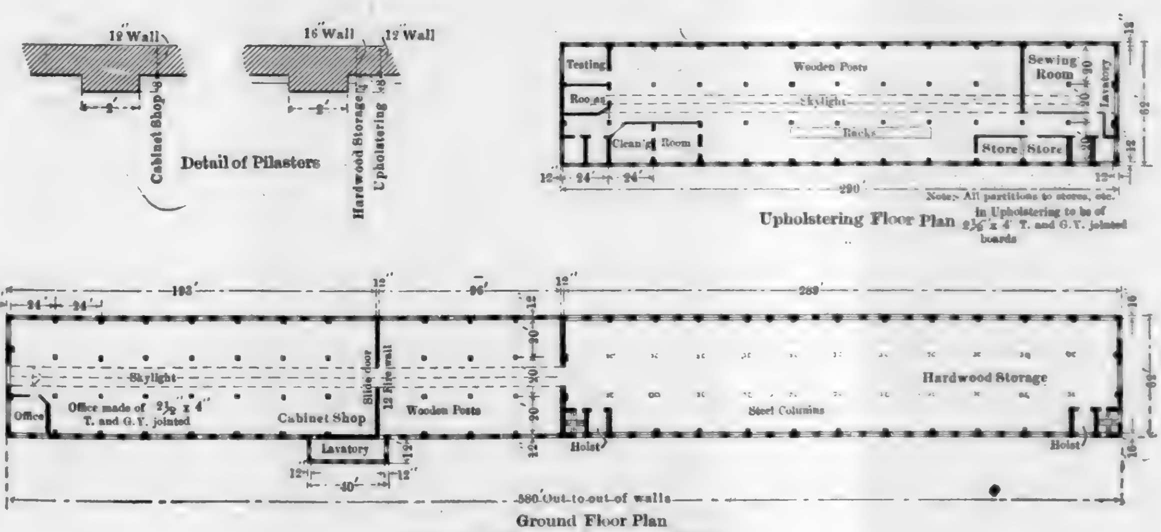
CABINET SHOP.

No.	Name and Maker.	Motor H.P.
	Double combination glue spreader	2
	Window blind mortiser, Jno. Bertram & Sons	5
	Window blind slot mortiser, McGregor, Gourley & Co.	
	Boults Carver, McGregor, Gourley & Co.	
	Royal Invincible sander, Berlin Machine Works	40
	Jig saw, C. P. R. make	7½
	Sash and door mortiser, Jno. Bertram & Sons	
	No. 3 band saw, McGregor, Gourley & Co.	
	Chain mortiser, No. 66, New Britain	5
	Sash sticker, McGregor, Gourley & Co.	
	Finishing saw, mitering work, Herbert Baker & Co.	10
	Band saw, 36-in. wheel, McGregor, Gourley & Co.	
	Double tenoning machine, 10-in. to 6 ft. 6 ins., McGregor, Gourley & Co.	15
	Four-headed inside moulder, McKechnie & Bertram	20
	Pony planer, J. A. Fay & Co.	
	Grindstone, 72-in., Pond Machine Tool Company	20
	Emery wheel, C. P. R.	
	Dimension saw table, 16 ins. wide, 3 ins. thick, McGregor & Gourley Company	
19.	Double-headed 16-in. saw, McGregor & Gourley Company	
20.	Perfection buzz planer and jointer, McGregor & Gourley Company	
21.	Dimension planer, sizing and straightening, McGregor & Gourley Company	15
22.	Swing saw, 16 in., C. P. R.	5
23.	Feed rod machine, ¼ to 1½ in., McGregor & Gourley Company	5
24.	24-in. wood lathe, McGregor & Gourley Company	5
25.	20-in. wood lathe, Smith & Coventry	
26.	Swing saw, 16-in., C. P. R.	5
27.	Universal wood worker, Egan & Co.	15
28.	Rip saw, 12-in., McGregor & Gourley Company	
29.	Panel planer, McGregor & Gourley Company	20
30.	Tenoning machine, McGregor & Gourley Company	
31.	Rip and cross cut saw, 14-in., McGregor & Gourley Company	
32.	3-sided inside moulder, McGregor & Gourley Company	15
33.	Chain mortiser, No. 66, New Britain Machine Works	
34.	Chain grinder, New Britain Machine Works	
35.	Shaping machine, McGregor & Gourley Company	10
36.	Shaping machine, McGregor & Gourley Company	
37.	Single spindle boring machine, McGregor & Gourley Company	10
38.	Friezing machine, J. A. Fay & Co.	
39.	2-spindle carver, Blouts	

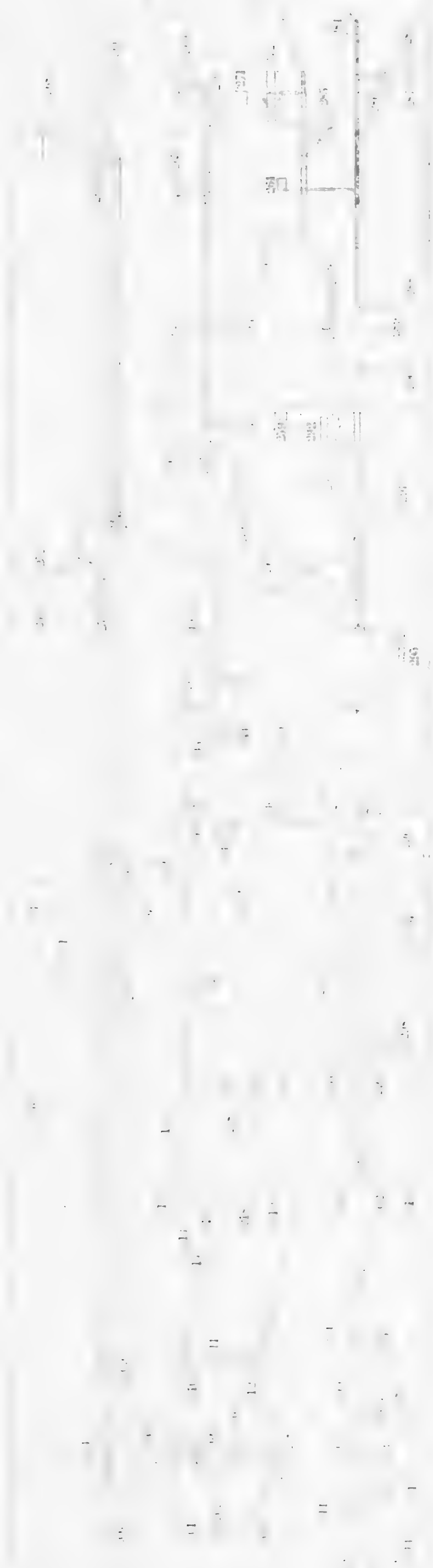
groups. All of the motors are placed overhead, with the exception of the large ones which run the planers, so as to allow plenty of floor space.

At the east end of the mill is an elevated extension platform which is used for a template and saw filing room. In the

INTERIOR VIEW OF PLANING MILL.



FLOOR PLANS OF CABINET SHOP.



PLAN OF SHAVINGS EXHAUST SYSTEM APPLIED TO PLANING MILL.

TESTS MADE ON MOTORS DRIVING FANS IN PLANING MILL, CAB[INET] SHOP, AND SHAVINGS TOWER.

(*Speeds observed with an Indicating Tachometer.*)

Fan	Vacuum — At fan inches	Vacuum — At end of pipe, inches.	Speed of fan — actual.	Speed of motor — actual.	Input. h.p.	Rated of mo[tor]
A	4 13-16	3 1-16	820	840	30.1	30
B	6¼	5⅝	830	890	30.3	30
C	4⅞	3⅝	815	860	23.2	30
D	4⅝	3¼	720	860	19.4	30
E	5	2½	880	885	18.1	20
F	4 11-16	3	725	900	19.6	30
G	5⅝	3 1-16	805	880	26.6	30
H	4⅞	3⅞	810	900	26.7	30
I	5⅛	2⅞	880	880	13.9	20
J	4⅝	3 1-16	820	880	19.8	30
K	5⅛	3¾	805	885	30.0	30
L	4½	3¾	800	875	20.5	30
M	5	4⅞	760	890	13.1	20
N	5¼	4 3-16	665	890	25.8	30
O	4½	3	800	514	27.4	30
P	11½	4¼	1,720	880	26.4	30
Q	7¾	7	1,100	900	22.5	20

Remarks.

Fans A to L are in planing mill; M and N in cabinet shop, and O to [Q] in the shavings tower.

Shutting off two inlets on pipes connected to fan K made a decrea[se] of 6 h.p. in motor input.

20-h.p. motor was found to take ½ h.p. running light with belt off, [a] 30 h.p. motor, 1.9 h.p.

PLAN OF SHAVINGS EXHAUST SYSTEM APPLIED TO THE CABINET SHOP.

CABINET SHOP.

Name and Maker.	Motor H.P.
...ouble combination glue spreader	2
Window blind mortiser, Jno. Bertram & Sons	
Window blind slot mortiser, McGregor, Gourley & Co.	5
...ults Carver, McGregor, Gourley & Co.	
...val Invincible sander, Berlin Machine Works	40
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...sh and door mortiser, Jno. Bertram & Sons	7½
No. 3 band saw, McGregor, Gourley & Co.	
Chain mortiser, No. 66, New Britain	5
Sash sticker, McGregor, Gourley & Co.	
Finishing saw, mitering work, Herbert Baker & Co.	10
Band saw, 36-in. wheel, McGregor, Gourley & Co.	
Double tenoning machine, 10-in. to 6 ft. 6 ins., McGregor, Gourley & Co.	15
Four-headed inside moulder, McKechnie & Bertram	20
Pony planer, J. A. Fay & Co.	
Grindstone, 72-in., Pond Machine Tool Company	
Emery wheel, C. P. R.	
Dimension saw table, 16 ins. wide, 3 ins. thick, McGregor & Gourley Company	20
Double-headed 16-in. saw, McGregor & Gourley Company	
Perfection buzz planer and jointer, McGregor & Gourley Company	
Dimension planer, sizing and straightening, McGregor & Gourley Company	15
Swing saw, 16 in., C. P. R.	5

No.	Name and Maker.	Motor H.P.
23.	Feed rod machine, ¼ to 1½ in., McGregor & Gourley Company	5
24.	24-in. wood lathe, McGregor & Gourley Company	5
25.	20-in. wood lathe, Smith & Coventry	
26.	Swing saw, 16-in., C. P. R.	5
27.	Universal wood worker, Egan & Co.	15
28.	Rip saw, 12-in., McGregor & Gourley Company	
29.	Panel planer, McGregor & Gourley Company	
30.	Tenoning machine, McGregor & Gourley Company	20
31.	Rip and cross cut saw, 14-in., McGregor & Gourley Company	
32.	3-sided inside moulder, McGregor & Gourley Company	
33.	Chain mortiser, No. 66, New Britain Machine Works	15
34.	Chain grinder, New Britain Machine Works	
35.	Shaping machine, McGregor & Gourley Company	10
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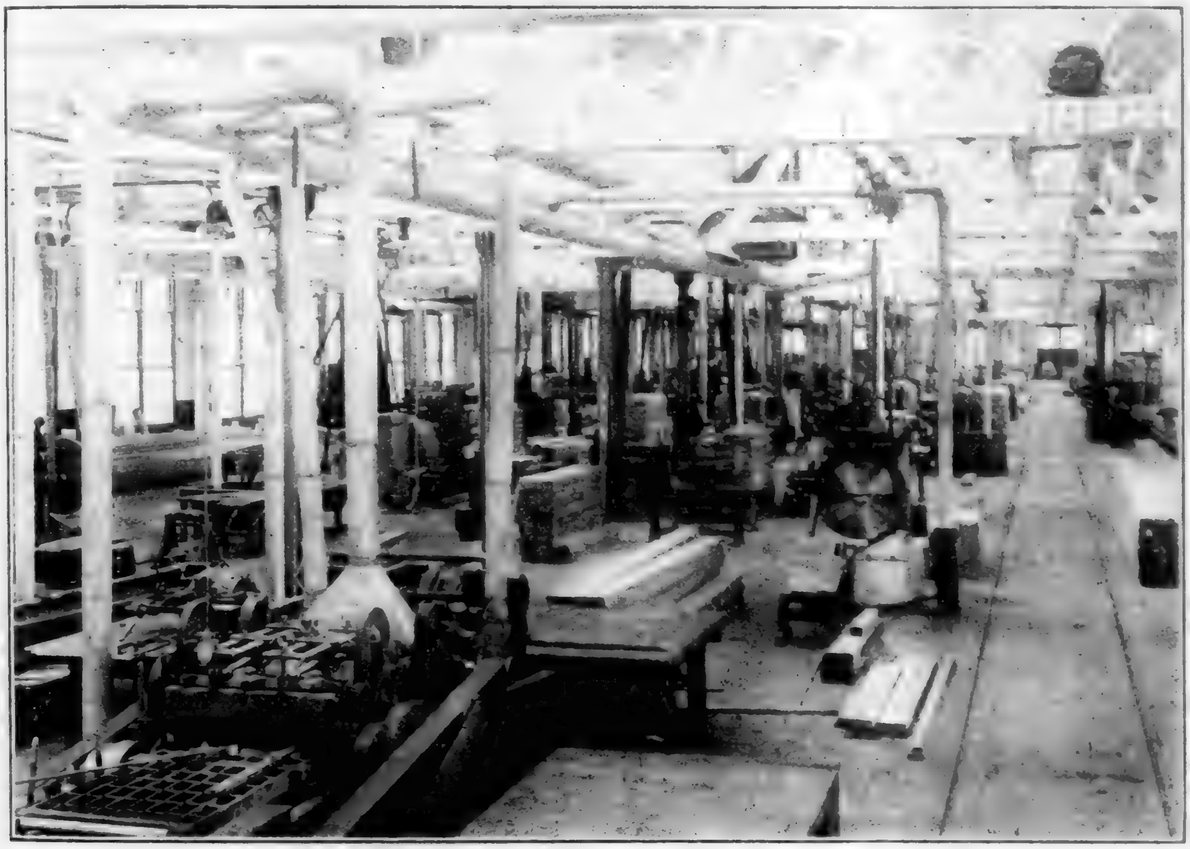
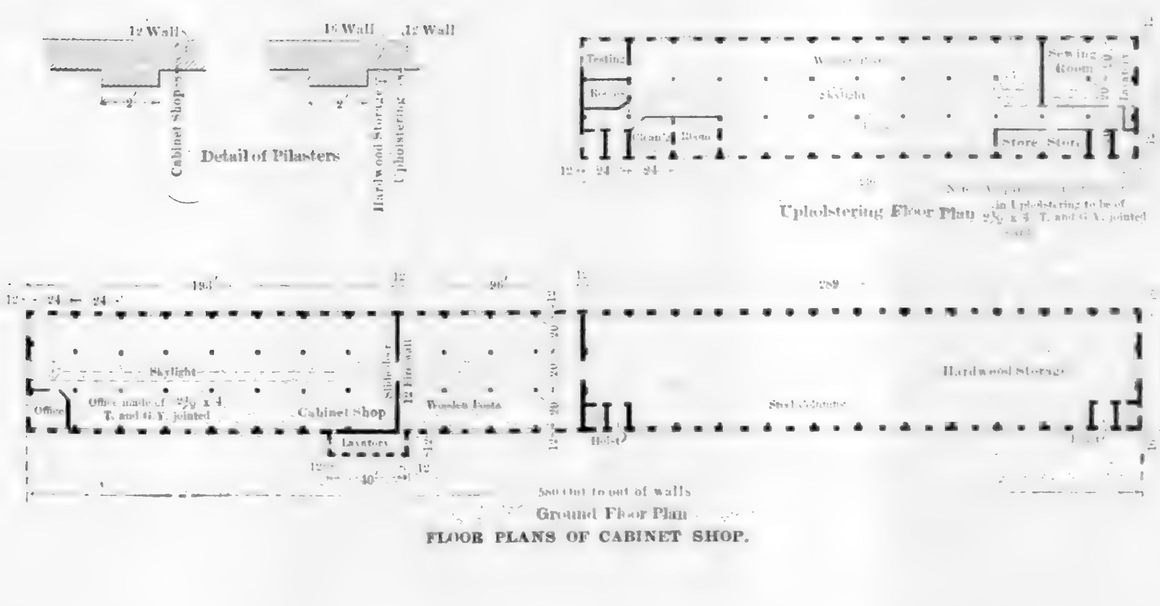


INTERIOR VIEW OF PLANING MILL.

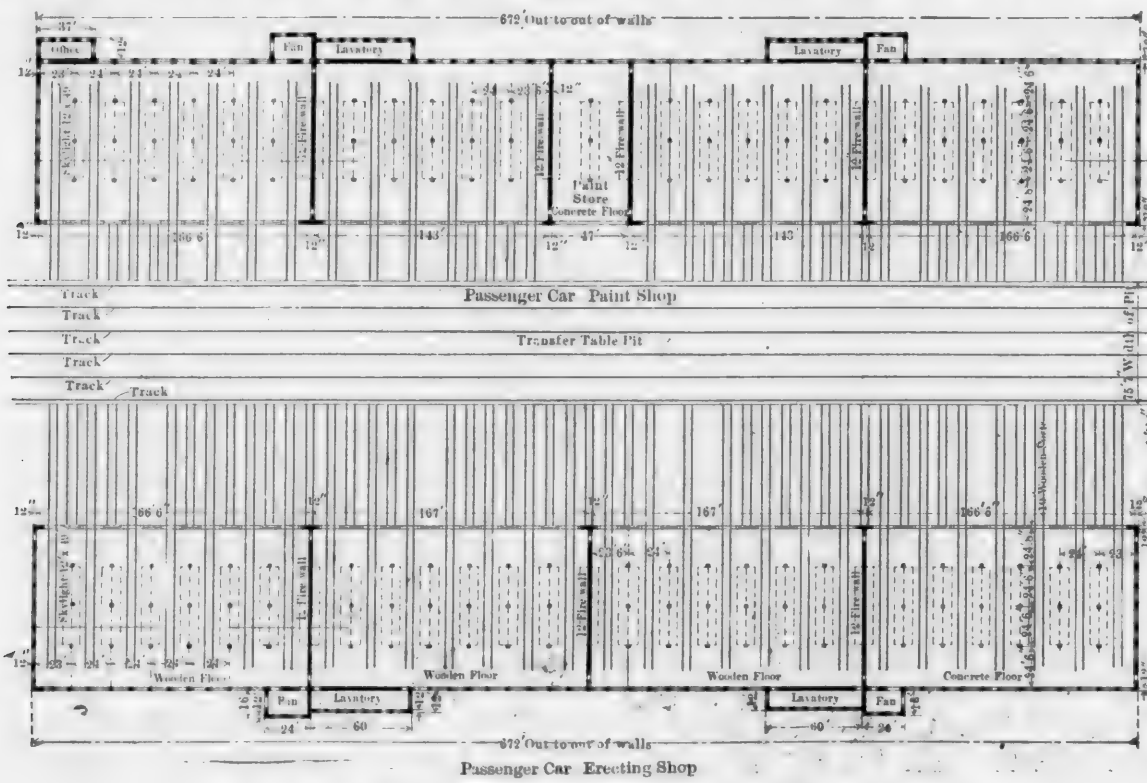


FLOOR PLANS OF CABINET SHOP.

saw filing room are four automatic knife grinders, one surface grinder for truing and sizing up blank steel for shaper and sticker knives, two automatic circular saw filers, two automatic band saw filers, one for small band saws and one for large band saws, and all the necessary tools for hammering and straightening circular saws, and also two emery wheel stands.

The number of men employed on the passenger side of the mill averages 100, and the number of men in the saw filing room is five. The number of men on the freight car side averages 75. The expected output for freight cars is twenty-five per day, and about fifteen passenger cars per month.

Cabinet Shop.—This shop is situated on the north side of one of the passenger car shops, with a large room for dry lumber at the east end. In the center is placed the wood-working machinery for cabinet work, and cabinet-makers' benches in the west end. This building is 62 ft. wide by 581 ft. long. The lumber is taken from the dry kilns, which are situated east of the lumber room, and taken into the lumber room and stored until required. From the lumber room it is taken to the wood-working machinery in the center, and from there to the cabinet-makers. The cabinet shop is equipped with a double set of light machinery for getting out interior finish for all classes of passenger equipment. The cabinet shop is also equipped with eight large presses for veneer work. Cabinet-makers are provided with double standard benches with tail screws.



PLAN OF PASSENGER CAR SHOPS, SHOWING TRANSFER TABLE.

Passenger Car Shops.—There are two passenger car shops. Each is 100 ft. wide by 672 ft. long. There are twenty-eight tracks in each shop, making a total of fifty-six tracks. The north passenger car shop is used exclusively for erecting of new passenger cars. There are five sections in this shop; four sections for the erection of new passenger cars and one section which is used at present as a paint store room and auxiliary store room. One side of the section is used for storage of paints and oils. All stencils are made in this room.

The other side of this section is used as an auxiliary store room, for car trimmings and hardware. There is also a large store room building situated south of the south passenger car shop controlled by the stores department, where supplies for both the passenger and locomotive departments are kept, and the idea of having the small auxiliary store in the north passenger car shops is so as to facilitate the work and avoid having to go over to the large store room for small quantitie The floor in the paint store room and auxiliary store room of concrete.

Both the north and south passenger car shops are we lighted and ventilated. There are arc lights in each sectic of these two shops, and also incandescent lights between tl tracks, so that the men working on cars may be enabled to d their work under all conditions. Portable electric light exte sions are furnished the men when working inside cars, an these extensions are connected to special plugs which are l cated on posts, and are made long enough so that the me working inside the cars may move around with them. Ther is a switch box in each section, so that the arc lights and in candescent lights are operated independently of each other The incandescent lights which are placed between the track may be operated individually, there being separate switche for each row of lights.

The south passenger car shop is composed of four sections and all repairing of passenger cars is done in this shop. One section in this shop is used exclusively as a "wash room," where the cars are placed upon being taken into the shop and stripped of doors, sashes and trimmings, and then immediately washed. Part of another section is used as a varnish room, where all sashes, doors and fittings belonging to cars are painted and varnished. This shop is fitted up similar to the north passenger car shop as regards ventilation, lighting, lavatories, etc. The skylights in both the north and south passenger car shops are so placed as to throw the light between the cars.

A 75-ft. transfer table serves the passenger car shops, operated by a 50-h.p. motor.

Each track of the south passenger car shop extends outside of the shop sufficiently to hold a passenger car for storage until such time as it can be taken into the shop, making a total of twenty-eight tracks for storage of cars. In addition to these twenty-eight tracks, there are a number of tracks at the east end of the passenger car shops, where cars are stored until such time as there is vacant shop room.

Before a car is taken into the shops it is placed at the east end of the north passenger car shop, when it is immediately stripped of all upholstering material, such as seats, seat backs, mattresses, pillows and spring beds, and after this equipment is removed the car is then placed in the "wash room" in the

..h passenger car shop, where it is washed and the heating ..ratus tested to ascertain defects. This being all attended .he car is then pulled out of the "wash room" and placed .nother section, where all necessary repairs are made. .n the repairs have been completed, the car is varnished . trimmed, and is then set outside of the shop and reported . service, and another car is taken in.

.HAVINGS EXHAUST SYSTEM.—This system uses Sturtevant .paratus, and was installed by the C. H. Gifford Company, of Philadelphia. It is applied to the planing mill and the cabinet shop, the location of the piping and the fans being indicated. In the large engraving showing the conduits for the planing mill those above the roof are shown in dotted lines This also applies to the cabinet shop. One of the photographs shows the conduits leading from the planing mill and the cabinet shop to the top of a shaving storage vault at the power house. The view of the interior of the planing mill illustrates the conduits inside of that building, and the three smaller photographs of the interior of the mill show the application of the system to a planer, a tenoning machine and a gaining machine. This system employs 17 fans of from 50 to 90 ins. in diameter, and running from 665 to 1,700 revolutions per minute, the maximum speeds of the fans in the planing mill being 880 ft. per minute. This dust collector system works admirably, and is designed to use large fans running at relatively slow speeds. The purpose was to instal a plant which would reduce to a minimum the constant charge for power, and the table of the performance, taken in a test made December 7th, 1904, shows the power required for this system. The longest run of conduit is about 700 ft., and the dimensions of the piping were selected with a view of rendering the power as efficient as possible. Space does not permit of the detailed description which this feature of the plant merits. In deciding upon the capacity for the equipment computations were made upon the difference between finished and rough dimensions of timber in a 30-ton box car. This amounts to 860 ft. board measure, or 72½ cu. ft. per car, and this volume will fill two or three times that space when put into the form of shavings and sawdust.

REPORT OF COMMITTEE ON POWER.

ROCK ISLAND COMPANY.

INDEPENDENT MOTOR CARS.

(*For previous article see page* 84.)

In the last six or seven years a number of composite motor cars have been built in this country and abroad for operating branch lines of steam railways where the travel is light and where the service requires the movement of about one carload of passengers at long or short intervals.

In many instances one car will afford accommodations enough at any one time for all the available business on branch lines. In such locations it does not pay to run a regular passenger train, as the wages of engineer, fireman and train crew, together with the general expenses of running such a train, are out of all proportion to the receipts. Better service, also, can often be rendered by one car frequently run than by a train making one or two trips a day.

The construction of these motor cars has usually consisted of a passenger car body with seats for about fifty passengers, one end being partitioned off to contain the boiler. A specially designed truck, carrying a vertical boiler and provided with horizontal steam cylinders, furnishes the motive power. Owing to the insufficient steaming capacity of the boiler, their development and use has not been as successful as might have been expected, nor has their introduction been as rapid. The limitations of vertical boilers within the height and space available is such that the cars have been very much handicapped with an insufficient steam supply. Even when fired in the best manner, it has been difficult to generate steam enough to supply the engines when working at maximum power. The heating surface, roughly speaking, is only about one-half that usually provided in modern locomotives. The fuel used in these cars has been coal, both hard and soft, and coke.

Two composite steam motor cars have been built at the Schenectady Works of the American Locomotive Company, one for the Erie Railroad on October 30th, 1897, and one for the New England Railway on October 9th, 1897 (See AMERICAN ENGINEER, November, 1897, page 368). A number of other cars have been built by the different builders in this country, but as they usually have vertical boilers of less heating surface than those mentioned, it is not considered necessary to illustrate them. The same remarks and limitations, therefore, are equally applicable to them.

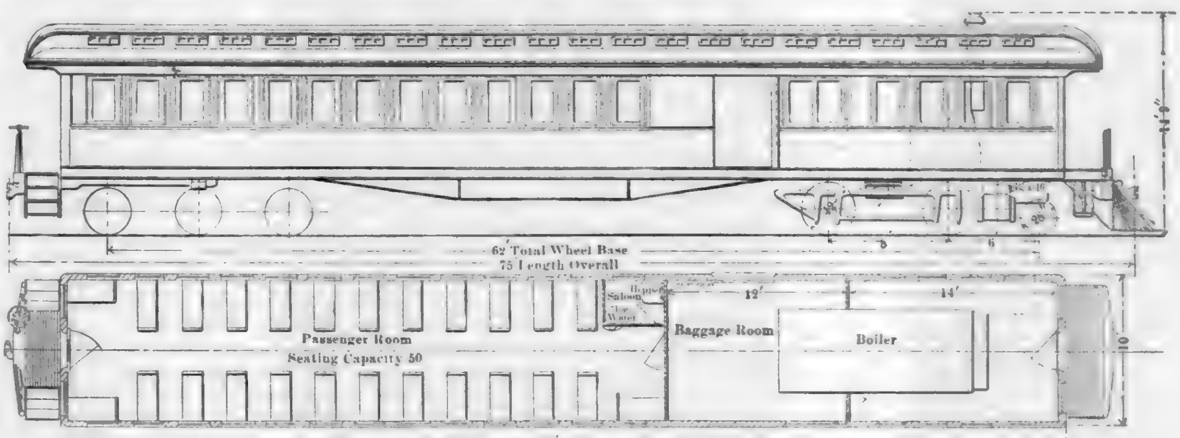
The largest number of composite motor cars have been operated by steam, but at the present time cars are being or have been built as follows:

First—Steam.

Second—Gasoline or oil engines in connection with direct coupled electrical generators and electric motors on the wheels. The arrangement of the motors, controllers, etc., is similar to the usual electrical street car method.

Third—Gasoline or oil engines with mechanical drive, operated by gearing and friction clutches.

While the use of gasoline provides some attractive features, being self-contained and not requiring any particular attention from the engineer except lubrication, the construction of these engines requires running at high speeds with a variation of not more than 40 per cent. or 50 per cent. Thus, in order to control the power and connect it to the wheels so that starting can be effected with smoothness and power, requires a large outlay for electrical or mechanical appliances. If controlled electrically, it requires a generator, two motors on the



SUGGESTED ARRANGEMENT OF STEAM MOTOR CAR.
ROCK ISLAND COMPANY.

COMPARISON.

Steam Motor Cars.

Engine number	4611	....	Proposed
Road	N. E. R. R.	Erie	....
Gauge	4 ft. 8½ ins.	4 ft. 8½ ins.	4 ft. 8½ ins.
Weight on drivers	70,000	75,000	74,000
Weight on truck	45,000	39,000	F 15,000
Weight on trailer	....	....	B 40,000
Weight, total	115,000	114,000	129,000
Wheel base, driving	8 ft.	8 ft.	8 ft.
Wheel base, total engine	56 ft. 10 ins.	....	62 ft.
Wheel base, total engine and tender	....	....	....
Cylinders, diameter and stroke	12 ins. x 16 ins.	10½ ins. x 16 ins.	12 ins. x 16 ins.
Cylinders, spread	78 ins.	78 ins.	78 ins.
Driving wheels, diameter	42 ins.	42 ins.	42 ins.
Driving wheel centers, diameter	36 ins.	36 ins.	36 ins.
Driving wheel centers, material	Cast iron.	Steeled iron	Cast steel
Driving journals	7½ ins. x 9 ins.	7½ ins. x 9 ins.	7½ ins. x 9 ins.
Trailing wheels, diameter	....	....	....
Trailing journals	....	....	....
Engine truck wheels	....	....	28 ins.
Engine truck journals	....	....	5 ins. x 10 ins.
Frames, width	3½ ins.	3½ ins.	3—½ ins.
Boiler, type	Upright	Upright	Horizontal with return tube
Boiler, diameter O. D. first ring	52 ins.	53⅛ ins.	60=½ ins.
Boiler, pressure	200 lbs.	200 lbs.	180 lbs.
Firebox, length and width	45⅝ ins. diam.	45 ins. diam.	48 3-16 ins. x 48⅝ ins.
Tubes, number of and diameter	318—1¼ in.	318 ¼-in.	397=1½ ins.
Tubes, thickness	No. 13	No. 13	No. 13
Tubes, length	4 ft. 8½ ins.	4 ft. 8½ ins.	7 ft. 6 ins.
Heating surface, tubes	489.6 sq. ft.	489.6 sq. ft.	875 sq. ft.
Heating surface, return tubes	....	....	350 sq. ft.
Heating surface, firebox	49.6 sq. ft.	49.6 sq. ft.	75 sq. ft.
Heating surface, total	529.2 sq. ft.	539.2 sq. ft.	950 sq. ft.
Grate surface	11.23 sq. ft	11.23 sq ft.	16.7 sq. ft
Tractive power	9,300	7,150	8,390
Factor of adhesion	7.52	10.49	8.82
Tank, type	2 cylindrical	2 cylindrical	2 cylindrical
Tank, water capacity	1,400 gal.	1,400 gal.	1,400 gal.
Tank, fuel capacity	1 ton coke	1 ton	1 ton

wheels and the usual arrangement of wiring, switches and controlling apparatus. It also involves the use of compressed air to start the engines. It is extremely questionable whether a gasoline-electric device of this kind would pay, unless gasoline could be obtained at an extremely low price or that coal could not be obtained except at a very high figure. The same argument is true of gasoline or oil engines with mechanical drive.

In reviewing this whole subject we are strongly of the opinion that a steam-driven composite car, with a large, properly constructed boiler (preferably horizontal), having sufficient steaming capacity and using fuel for oil, is the best solution of the problem. If the valves controlling the admission of oil and air were arranged very conveniently for the engineer, it would take but a small part of his time to control and maintain the steam pressure.

A preliminary design of such a car is shown. This car has a seating capacity of fifty passengers and a small baggage room. The steam connections between the boiler and engine are made with flexible ball joints. Such ball joints can be made in a satisfactory manner, and be guaranteed to give practically no trouble.

As fuel oil is abundant in different points in Kansas, Texas, etc., reached by the Rock Island System, it would seem to be peculiarly fitted for service on that road. The application of superheating pipes to the boiler should also be considered, as a large saving can be effected by their use, in water and fuel.

Illustrations and descriptions of a number of composite motor cars built at home and abroad are included in the report as follows:

Railroad.	Country	Motive Power.	Fuel	Total Weight
New England R. R.	U. S. A.	Steam	Coke	115,000
Erie R R.	U. S. A.	Steam	Coke	114,000
Proposed	U. S. A.	Steam	Oil	129,000
Great Western Ry.	England	Steam	Coal	......
Taff Vale Ry.	England	Steam	Coal	......
S. W. & L. B. & S. C.	England	Steam	Coal	......
North Eastern	England	Mot. & Elec	Petrol.	73,400
Paris-Orleans Ry.	France	Steam	Coal	......
C. B. & Q. Ry.	U. S. A.	Gaso.-elec.	Gasoline	......
Midland	England	Steam	Coal	58,760

Motor Coaches Used by the Taff Vale Railway Between Cardiff and Penarth.—"These find much favor with the Taff Vale Company, who are about to construct six more motor coaches, propelled by steam, practically uniform with the one now running between Cardiff and Penarth. The dimensions of this motor coach are: Length over all, 58 ft. 9 ins.; width, 8 ft. 6 ins.; length of first-class compartment (seating capacity, 12), 8 ft. 11 ins.; length of third-class compartment (seating capacity, 40), 26 ft. 1½ ins. The first-class compartment seats are placed longitudinally and face each other; the third-class the seats are transverse, seating two passengers on each side. A central gangway runs throughout. There is no second-class, the seating capacity of the third-class being apparently designed to meet both classes. Though the running of this steam coach between Cardiff and Penarth has attracted public interest and support, it cannot yet be hailed as the fore-runner of the establishment of this means of transit in other directions, until the economy of working for it has been proved by experience. This consideration has undoubtedly been the moving power which has dictated the policy of the Taff Vale Company in introducing these steam motor coaches, apart from any hoped-for permanent stimulation of traffic that might be the reward of their enterprise. The cost of running them is said to be one-third that of running a train and four carriages, drawn by an engine of the type in ordinary use which they are intended to displace on that railway. In supporting this estimate we specifically show below cost running (1) a motor coach per train mile and (2) an engine and four coaches per train mile, respectively, namely:

Running.	Motor coach cost per train mile. d.	Engine and four carriages cost per train mile. d.
Engine coal	1.36	3.03
Water	.12	.36
Oil and other stores	.19	.46
Cleaning	.07	.33
Steam raising, etc.	.09	.10
Washing out	.03	.08
Carriage lighting	.12	.32
Carriage cleaning	.10	.55
Oil	.01	.05
Repairs, Renewals.		
Engines	.95	3.48
Carriages	.51	2.75
Wages.		
Enginemen	1.37	1.96
Trafficmen	.56	1.45
(10.96 cts.)	5.48	14.92 (29.84 cts.)

(Extract from the "Railway Age," March 11th, 1904.)

Motor Electric Cars, Northeastern Railway.—Electric cars for the Northeastern Railway of England, 52 ft. long, seating 52 passengers, are driven by a four-cylinder petrol engine built by Wolseley Tool & Motor Car Company of Adderly Park, Birmingham, England, with a rating of 80 brake h.p. at 420 r.p.m. This drives a compound wound separately excited dynamo rated at 55 k.w., which supplies current to two 55 h.p. tramway motors mounted on the front truck of the car. The motor has cylinders 8½ x 10 stroke. Consumption of gasoline, 0.78 pints per h.p. at full load.

Gasoline Electric Car Built by the C., B. & Q. Railway.—This car is driven with a 225-h.p. 3-crank engine coupled direct to a Crocker-Wheeler multi-polar generator mounted on the same bed plate. This car is made with a steel channel frame about 32 ft. long over the bumpers. The driving truck is a Peckham 4-wheel street car truck with 32-in. wheels directly under the engine, but on the other end of the car is a pair of trailing wheels working in a pedestal so that the car is car-

Table 1.—Cost of Operating 300 Horse Power Motor Car.

Type of car.	Cost of fuel. Per gal. or ton.	Cost of fuel. Per pint or lb.	Lbs. or pints per h.p. hr.	Cost per h.p. hr.	H.p. hrs. per day.	Cost of fuel—Per day—While running.	Cost of fuel—Per day—Additional for raising steam.	Cost of fuel—Per 1,000 h.p. hrs.
Gasolene	$0.12	*1.5	1.	1.5 cts.	1,500	$22.50	$22.50	$15.00
Steam car with simple engines; oil fuel	.024	†.32	†2.8	.89	1,500	13.35	14.70 (10%)	9.20
Steam car, compound engines, superheated steam, oil fuel	.024	†.32	†2.1	.67	1,500	10.05	11.00 (10%)	7.33
Steam car, simple engines, coal fuel	2.15	†.1075	†4.	.043	1,500	6.45	8.06 (25%)	5.33
Steam car, compound engines, superheated steam, coal fuel	2.15	†.1075	†3.	.032	1,500	4.83	6.04 (25%)	4.03

*Pints. †Pounds. Running 100 miles a day. Average horse power assumed to be 150. Weight of oil, 7½ lbs. = 1 gallon.

ried on three pairs of wheels. The 4-wheel truck is supplied with two 125-h.p. street car motors. The engine, controller, air tanks, etc., occupy all but 11 ft. of the car, the remaining space of 15 ft. being used for carrying mail. The intention is to carry passengers in a trailing passenger car. A tank containing 300 gallons of gasoline is located underneath the car. The engine is started by means of compressed air, two tanks of which are provided, standing vertically on either end of the car inside the cab. The motor is supplied with an electrical

Table 2.—Saving in Operation of Motor Car and Two Car Train with Locomotive.

Approximate cost:	
Passenger cars	$5,000
Baggage, mail and express cars	5,000
Engine and tender	7,000
	$17,000
Motor car	12,000
Difference	$5,000
Weight of train:	
Passenger car	35 tons.
Baggage car	30 "
Engine and tender	65 "
	130 "
Weight of motor car	65 "
Difference	65 "

Cost per day for wages:

	Train.	Motor car.
Engineer	$3.50	$3.50
Fireman	2.25	2.25
Conductor	3.50	3.50
Brakeman	2.00	
Baggageman	2.50	$9.25
	$13.75	
Add for R. H. care	3.00	
	16.75	
Add interest on $5,000 at 6%	1.00	
	$17.55	

Cost of operation of train per day	$17.55
Cost of operation of motor car per day	9.25
	$8.30
Saving in fuel per day	5.00
Total saving per day in operation of motor car	$13.30

Capitalized at 5% $\frac{13.30 \times 360}{0.05} = \$95,760.$

air compressor similar to that used on heavy street cars. The engine is designed to run continuously at 325 r.p.m. The controlling apparatus, valves, etc., are placed in one end of the car only, the intention being to turn the car around at each end of the run.

The report presents the cost of operating a 300-h.p. motor car and also a statement showing the saving in operation of a motor car over that of a locomotive with a two-car train. These are presented in Tables 1 and 2.

ROLLED STEEL CAR WHEELS.

"Rolled-Steel Car Wheels" was the title of a paper by Mr. S. M. Vauclain, recorded in the *Journal of the Franklin Institute* for February, 1905.

The author first paid tribute to the cast iron wheel, which had done satisfactory service, but is now taxed beyond its limits because of increased wheel loads, it being impossible to increase the weight of the wheel in proportion to the loads. Brittleness of the flange, inability to resist the heating effect of the brake shoes, shelly treads and internal stresses in the castings had created a field for a wheel which would be free from these objections. The high-priced, steel-tired wheels which have been used under passenger equipment are considered too expensive for freight equipment. An "aching void" was left between the two. A safe, durable and cheaper wheel was wanted.

For making such a wheel long ingots were necessary. The process of manufacture was simple; a long upper section of the ingot must be discarded, the lower sections cut and pressed into blanks under a 5,000-ton hydraulic press, the blanks then rolled into wheels by special machinery, which would properly "work" the tire portion. The process of the Standard Steel Works was described. Tables of analyses and physical tests showed remarkable uniformity of the product. Drop tests of these wheels showed that 13 blows of a 2,240-lb. weight, 8 of which were from a height of 30 ft., were required to break a 36-in. wheel. Another wheel received 17 blows, of which 9 blows were at 25 ft., to break the wheel when struck on the top, in running position. Thermal tests were also fully met by these wheels.

Mr. Vauclain presented the following commercial comparison of steel and cast iron wheels:

SOLID ROLLED WHEELS.

Cost of pair of rolled wheels	$54.00
Cost of four turnings	2.40
Cost of four removals and applications	2.40
	$58.80
Less scrap value	8.75
Net cost	$50.05
Mileage, 350,000.	
Cost per 10,000 wheel miles, $1.43.	

CHILLED-IRON WHEELS.

First cost of pair of chilled-iron wheels	$18.00
Cost of boring and mounting	80
Cost of removal and application	60
	$19.40
Less scrap value	5.80
Net cost	13.60
Mileage, 80,000.	
Cost per 10,000 wheel miles, $1.70.	

It is usual for the railroads to determine the average cost of wheels by dividing the total yearly cost by wheel mileage made during the year. The statistics vary from 1.65 to 1.78, the average closely checking the foregoing estimate.

The natural field for the rolled wheel, according to Mr. Vauclain, is: (1) The severe service of engine and tender trucks, in which steel-tired wheels are now exclusively used. (2) Passenger car equipment, in which the element of safety plays an important part. (3) Heavy freight car equipment, for which the chilled-iron wheel has proved inadequate.

AN ECONOMICAL POWER PLANT.

A coal consumption as low as 1.7 lbs. per kilowatt hour under favorable conditions, and an average coal consumption of 2.25 lbs. per kilowatt hour for a period of three months, during which the load factor was .55 and the heat value of the coal used was about 13,500 B. T. U., is, indeed, a remarkable showing, and indicates that the gas engine and the methods of producing gas for its use have become developed to such an extent as to make it a formidable competitor of the steam engine. These results were obtained at the 705 h.p. gas engine power plant, which furnishes power and light for the malleable iron and the new steel plants of the Gould Coupler Company and also for the Gould Storage Battery Company's plant at Depew, N. Y. This power plant has been in operation for several months, and while figures are not yet available as to the cost of operation, indications are that it will be less than for a steam power plant of the same size.

Three 3-cylinder, 19 by 22 ins., Westinghouse 4-cycle, 235-h.p. vertical type gas engines operate direct connected 150-k.w., 250-volt direct current Westinghouse generators. The engines are guaranteed for 260 brake h.p., using gas with a heat value of 125 B. T. U. Ordinarily, two of the engines are sufficient to carry the load, but it is frequently necessary to use all three of them. A mixture of water and producer gas, as made by the Loomis-Pettibone process of the Power and Mining Machinery Company, is used. The engines are started by compressed air at 100 pounds pressure, which is furnished by a two-cylinder Rand, 6 by 6-in., compressor, driven by a 10-h.p. Westinghouse motor. One of these engines may be started and the full load thrown on it in less than a minute and a half. They can also be easily stopped at the starting point, which is just off the centre.

The ignition outfit consists of the standard Westinghouse spark coils, operated by a Diehl motor-generator and Gould storage batteries. Jacket water for the engine is pumped from the reservoir, shown in the foreground of Fig. 1, by Worthington turbine pumps. The gas engines, switchboard, ignition outfit, air compressor and air reservoirs are in a steel frame brick structure, inside dimensions 45 by 61 ft., with one end constructed with a view to future extension. This is equipped with a 10-ton hand traveling crane, the runways of which are 24 ft. above the floor. The pumps are in the basement of the building.

The arrangement of the apparatus in the gas producer plant is shown in Fig. 3. This consists of three gas generators, a boiler, wet scrubber, dry scrubber and exhauster. The gas holder, with a capacity of 15,000 cubic ft., is about half-way between the producer plant and engine room. The diagram in Fig. 4 illustrates the operation of a Loomis-Pettibone gas

FIG. 1.—GAS ENGINE POWER HOUSE TO THE RIGHT, WITH RESERVOIR IN THE FOREGROUND.

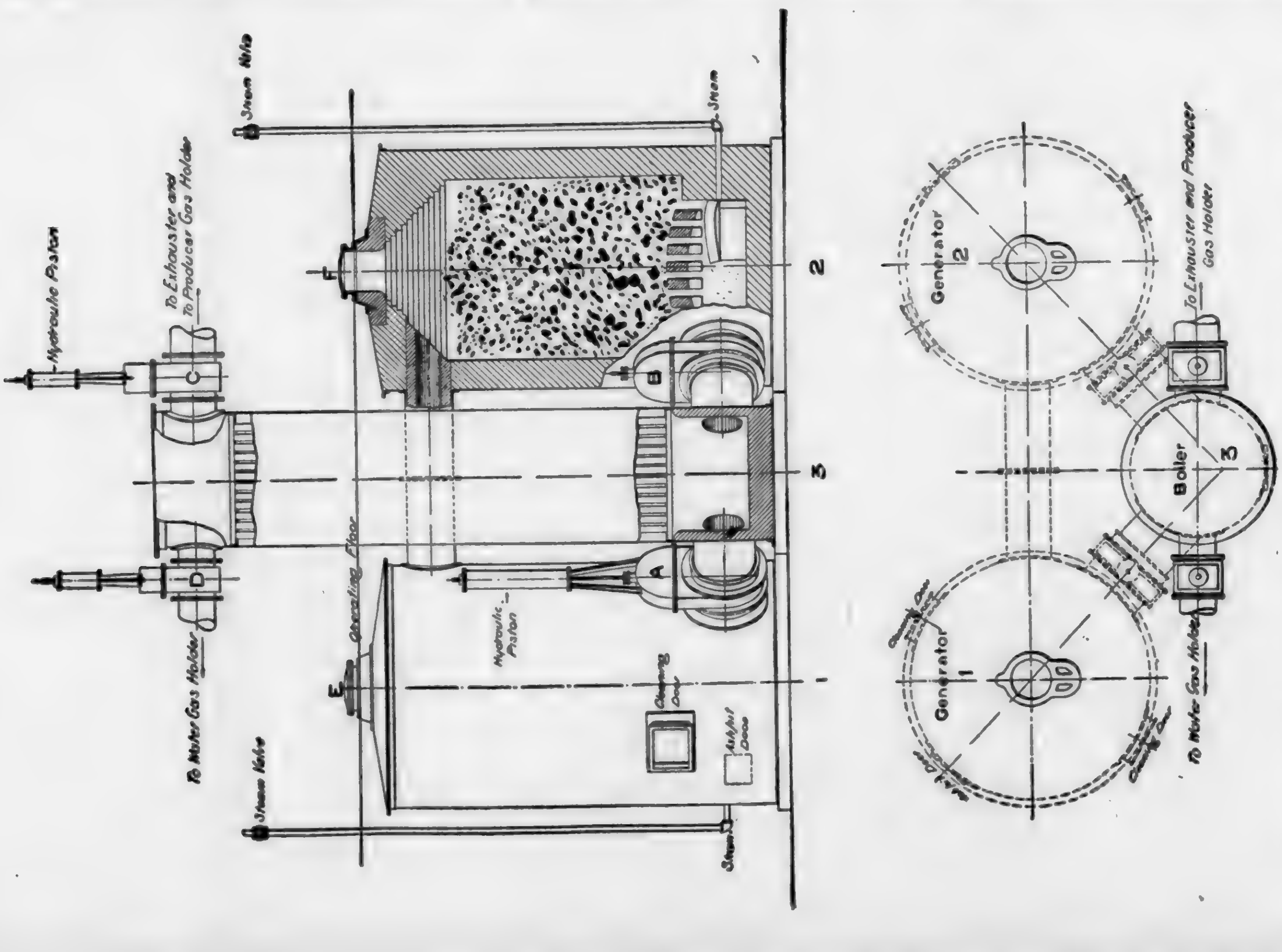


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FIG. 2.—INTERIOR OF ENGINE ROOM, SHOWING WESTINGHOUSE GAS ENGINES AND DIRECT CONNECTED ELECTRIC GENERATORS.

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FIG. 3.—ARRANGEMENT OF THE GAS PRODUCER APPARATUS.

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The reservoir, which has a capacity of 1,000,000 gals., is divided into two separate parts, one for the gas engine jackets and the other for the wet scrubber in the producer plant. It is 10 ft. deep, and is supplied by rain water from the roof of the steel plant. The fresh water flows into that part which is used for jacket water, and which must be kept as pure as possible. This overflows into the part used for the wet scrubber, and which is maintained at a slightly lower level, and must not be mixed with that used for the jackets, as it soon becomes dirty.

We are indebted for this information to Mr. F. P. Huntley, secretary of the Gould Coupler Company.

MANGANESE STEEL RAILS, BOSTON ELEVATED.—This road, because of serious wear of rails on its extraordinary curves, has put down a number of manganese steel rails which are cast because they cannot be rolled. The results thus far, according to the *Railroad Gazette*, are very satisfactory. These rails cost $5 per foot, while Bessemer rails cost but 38 cents. The difference in durability is considered to more than balance the increased cost.

SIMPLON TUNNEL.—This famous and difficult work, which began in August, 1898, has been connected, and within a few months will be in service for a single line of rails. When the traffic reaches $16,000 per mile annually the second tunnel will be completed by the Swiss Government. The Alpine tunnels are listed in *Engineering* as follows:

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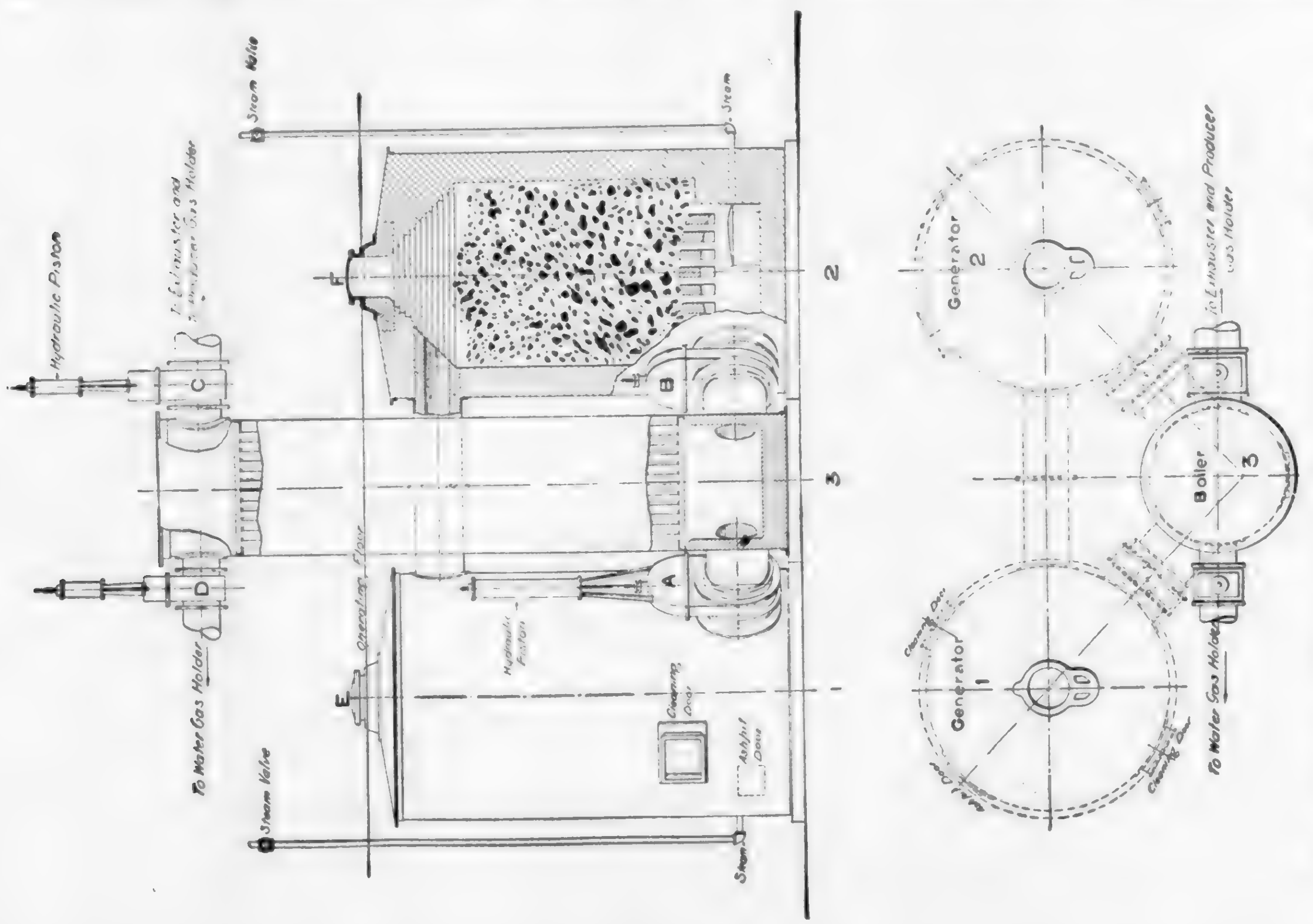

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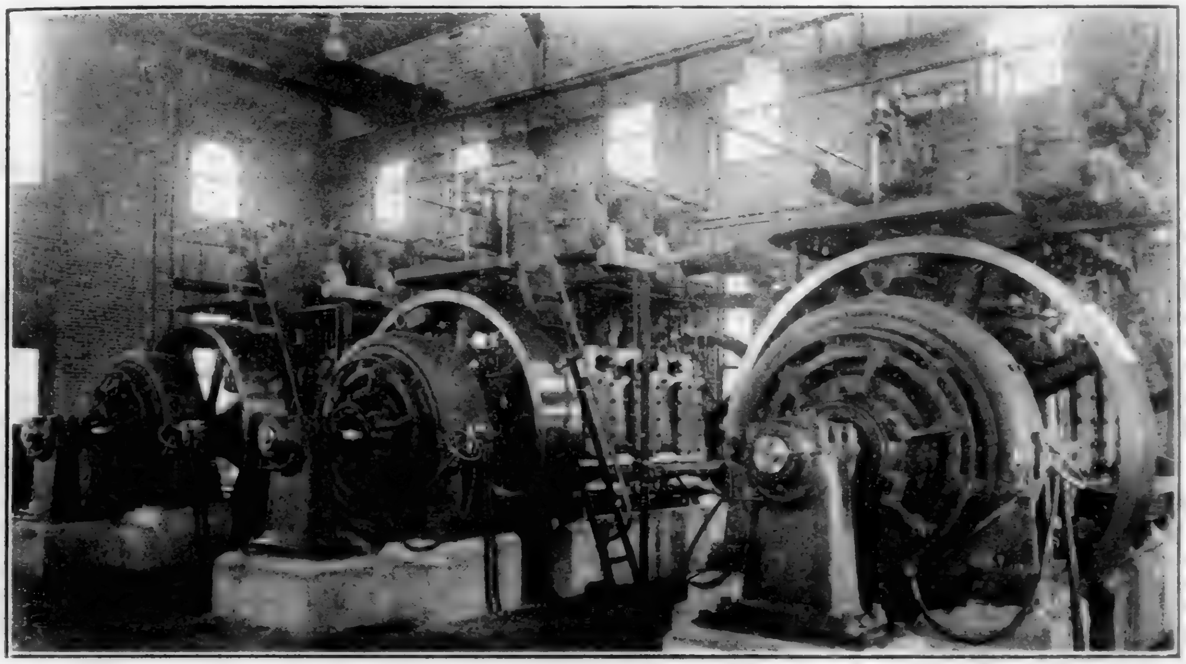

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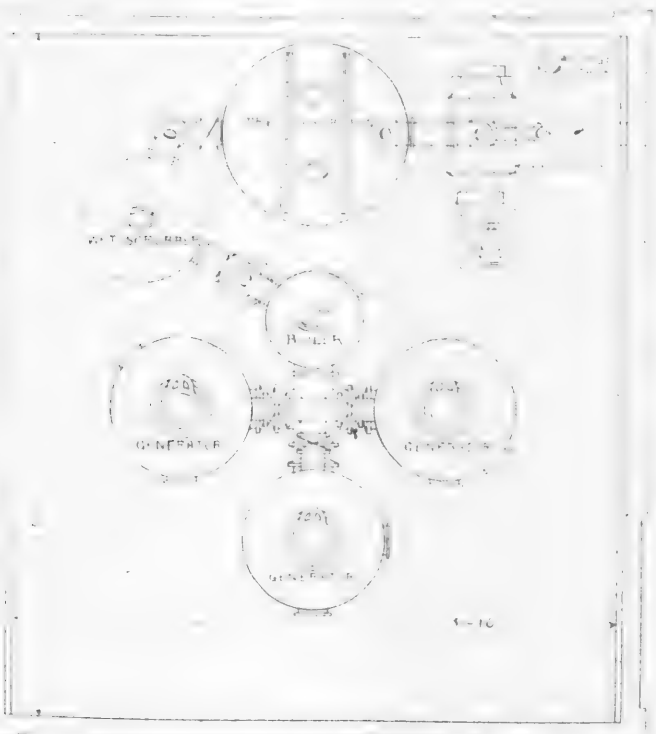

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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We cordially invite our many friends attending the conventions at Manhattan Beach in June to make use of our offices. Telegrams and mail addressed in our care will receive careful attention.

INTERNAL COMBUSTION ENGINES.

There is no reason why the remarkably low average coal consumption per k.w. hour at the gas engine power plant, described on another page of this issue, could not be duplicated if similar plants were installed to furnish power for railroad repair shops. Its operation is, if anything, more simple than that of a steam plant. The gas engine and the methods of producing gas for its use are beyond the experimental stage and are thoroughly reliable. It is interesting to note in this connection that the preliminary report of the United States Geological Survey on the coal-testing plant at the Exposition shows that for comparative tests of 14 different bituminous coals one ton used in a gas producer plant developed as much power on a commercial scale as 2½ tons of the same coal used in an ordinary steam plant. The importance of this question merits the careful study of those contemplating the construction of new power plants.

ELECTRIC TRACTION FOR STEAM ROADS.

The trend of the discussion on this subject at the March meeting of the New York Railroad Club indicated that there was still much uncertainty as to how far the single phase alternating current system will displace the direct current system for this work, because of the pulsating torque of the A. C. motor and the relative lower efficiency and higher first cost and also the fact that the apparent resistance of the trolley and track is from one-half to twice as great for the alternating current as for the direct current. Much depends upon the practical experience to be gained from the single-phase alternating-current systems now in use and about to be installed. Apparently, steam roads will adopt electric traction, not because of economy in operation, but because of other advantages to be gained by its use. While improvements will undoubtedly be made in the electric motors much progress will also be made in the next few years toward making the steam locomotive more economical. Most of the speakers favored the use of the third rail in preference to the overhead trolley. The speakers were very cautious in their prophecies concerning the substitution of electric traction on steam roads.

WEARING-OUT POLICY FOR SHOP MACHINERY.

It is one thing to abuse shop tools and quite another thing to use them up quickly in legitimate work. The writer recently heard a general foreman scold a machine hand severely for damaging a tap, which, in his anxiety to turn his work out quickly, was injured in the machine. This brought to light the fact that in that shop a rule is in force requiring a broken tool to be taken to the general foreman and a satisfactory explanation given before another tool can be issued to the offender. Such a rule as this may work harm rather than good, and it is a question whether it is advisable to lay such stress on the breakage of small tools when in legitimate service, for the reason that men may easily be led thereby to nurse the machines and the tool equipment at the expense of the output. If a good system is in force it is not likely that machine operators will wilfully break their tools and as a general proposition it would be advisable to break a good many, if thereby a sharp pace may be gained in the shop. Of course, wanton destruction should be guarded against.

No one nowadays thinks of nursing a locomotive at the expense of its output, but it is considered a great mistake to encourage men to take such care of the machine as to limit the work done. Within reasonable limits the policy in a railroad shop to-day should be to wear out the tools and machinery in an effort to get the proper value out of them day by day. As to machine tools it would seem to be an excellent policy to fix on a certain period of years as the maximum life of the tools and to push them to the utmost to accomplish their life work in that time. Instead of giving an honored place to antiquated machinery, in an otherwise modern railroad shop, these tools should at the proper time give place to new ones, providing improvements in that particular line of machinery justify the change. A general adoption of such a policy would lead to a business-like plan of providing for depreciation, as is suggested in the admirable paper by Mr. M. K. Barnum, which appears in this issue.

LIGHT MOTOR CAR UNITS.

A correspondent recently asked for information concerning the development of motor cars for relatively light service on branch lines, and was surprised to find that so little had been done in this country. His letter closed as follows:

"It seems to me very curious that a field which presents such possibilities has been left undeveloped so long."

In Europe the development has been much greater, although electric line competition has been less serious there than here. Careful attention to this problem cannot be longer delayed in this country, and substantial developments are to be forthcoming in the immediate future. These light units are only to be considered as a bridge across the gap between steam and electric traction, and for this reason may be considered as a makeshift and not a permanent development. The problem, nevertheless, is exceedingly important and attractive. We cannot, under our conditions, follow present foreign practice, but must develop our own. Internal combustion motors present favorable arguments for adoption, but opinion is divided as to whether, after all, steam is not the only satisfactory power for this purpose. If so, the line to be drawn between a light steam locomotive and the self-contained unit is a difficult one to draw. The report of the Power Committee of the Rock Island System on this subject is one of the most important recent documents relating to it, and this appears elsewhere in this issue.

Unless a steam boiler of high capacity for its weight is developed, it will be difficult to use steam because of boiler limitations. In this connection the flash boiler has interesting possibilities and it is now receiving attention from engineers who have been associated with the greatest developments of power for railroad transportation.

Gasoline engines are being tried with fair promise of success, but kerosine engines are considered seriously for the next step in development because of the superior safety of the heavier oil. This is an important factor.

The demand for light units has appeared in proportion sufficient to merit the attention of the ablest engineers, and this in itself is sufficient assurance that it will soon be met.

LOCOMOTIVE TESTING PLANT.

PENNSYLVANIA RAILROAD.

This plant was designed and built with a view of permanent installation at Altoona, after the close of the World's Fair at St. Louis. While accessories may be changed, the plant itself is to be erected again, probably without important changes. Its original construction was rapid, and the design provided for gauges permitting the work to progress simultaneously at Altoona, where many of the details were made, and at Philadelphia, where the dynamometer and main bearings were built in different establishments. The plant was not assembled before its erection at St. Louis. Fig. 1 presents a side elevation as arranged at St. Louis, and Fig. 2 is an end view.

Upon a very large concrete foundation (Fig. 1), gradually increasing in depth toward the rear and deepest under the dynamometer, two cast iron bed plates were placed. These were slotted to receive the bolts for the pedestals of the carrying wheels, rendering them adjustable for locomotives of varying wheel bases, varying number of wheels and different wheel spacing. A set of 5 pairs of supporting wheels were 50 in. in diameter and another of three pairs of 72-in. wheels were provided, the smaller ones being for freight and the larger for passenger locomotives. Each set of carrying wheels had a corresponding set of pedestals fitted with very large, carefully designed bearings, having provision for water circulation to insure cool running. An exceedingly important part of the plant, which cannot be properly illustrated, was the arrangement of moveable track at the front end of the engine, which was adjusted longitudinally to suit any engine to be put upon the plant. This telescopic track was successful in every way and contributed largely to the satisfactory handling of the plant. Fig. 4 shows in section one of the long I beams extending the full length of the plant. After the supporting wheels are spaced and trammed, these beams are bolted to the inside faces of the supporting wheels and the flanges of the drivers of the locomotive run in the groove in the rail which is bolted to the I beams. The drivers rise slightly on their treads as they pass over the carrying wheels, and finally stop when each driver is resting upon its wheel. The I beams are then taken away from the carrying wheels, the truck is supported on the structure shown in Fig. 5, and the locomotive is ready for attachment to the dynamometer.

Fig. 4 also shows the tire of the carrying wheel in section, with the inclined groove, cut out, to throw oil from the outer edge of the tire, away from the locomotive tire, in case oil gets upon the supporting wheels. Fig. 4 also shows the tire retaining ring which, with the shoulder on the wheel center, holds both ways. One of the supporting wheels, the bearing and the brake are shown in Fig. 6, and the construction of the brake and the end of the supporting axle are shown in Fig. 3. The sectional views indicate the method of removing the brake from the taper fit at the end of the axle. A nut forces the brake on the shaft and another forces it off. It also shows the centrifugal oil grooves at the brakes. The Alden brakes consist of outer casings held from revolving at R, R. Discs D attached to the hub, revolve inside the casing when the supporting wheels are turned. Against these discs copper plates, C C, attached to the casing bear with hydraulic pressure and cause the desired resistance by friction upon both sides of the discs. The discs have radial grooves and lubrication is provided to avoid heating and seizing. The spaces marked W contain circulating water under pressure, causing the plates to bear heavily against the discs. By varying this water pressure the speed of the locomotive is under practically perfect control. It is varied by throttling the outflowing water, this circulation serving to carry away the heat resulting from the friction. The discs are oiled from a large supply at the center of the casing, on each side, and oil is carried to the outside of the casing by centrifugal force, being discharged upon each side at the top. It therefore circulates when the plant is running.

A smoke jack removed the smoke and gases from the stack through the roof of the building. This was made adjustable and telescopic. It also provided for the retention and measurement of the cinders.

An adjustable drawbar connected the locomotive to the dynamometer. It was found necessary to provide dash pots to control the vibration of the drawbar, and these are clearly shown in Fig. 7. In order to avoid introducing errors into the measurements, these dash pot rods were attached to the locomotive and to the dynamometer housing by universal joints with carefully designed and constructed adjustments, which also permitted the attachments to be easily applied and removed. The dash pots contain oil supplied from founts and their resistance to motion was adjustable by means of valves in the casings. The dash pots are in the form of double discs ground to fit their cylinders with about 0.001 in. clearance. These are arranged so that only a static head of oil comes upon the stuffing boxes.

A very large housing provides for the 80,000-lb. Emery dynamometer, built by Messrs. Wm. Sellers & Company, Philadelphia. This is a development of the Purdue dynamometer and that of the Pennsylvania Railroad dynamometer car, employing Emery flexure fulcrums, which were used in the Emery testing machines. These are well adapted to carry large levers under heavy loads and yet introduce only negligible friction. The dynamometer is adjustable 12 ins. vertically by means of screws turned by a hand wheel, shown in Fig. 9. This adjustment permits the height of the drawbar to vary from 30 to 42 ins. above the rail level.

In the engravings, Fig. 9 shows a side view, plan and end view of the dynamometer structure, the recording attachments being shown in Figs. 8, 10 and 14. The dynamometer housing is very substantial, consisting of the castings A and B, with projections extending down into the concrete foundation. The dynamometer itself is placed between the abutments C, which are connected together by the heavy plates B. This structure must necessarily be very rigid, and the anchorage to the foundation secure. The drawbar connection is shown at the right of the side view in Fig. 9. The weight of the drawbar is taken upon two flexible steel plates and it is held in alignment by flexible rods, which provide for its motion without friction. A ball and socket joint permits the drawbar to accommodate itself to slight motion of the engine without bending the connection. The dynamometer itself is so compact as to render a description from working drawings impossible. Fig. 13 shows the principal parts arranged for purposes of explanation. This view shows the levers, with their Emery fulcrums. To support the weight of the levers and prevent both horizontal and vertical stresses, which would cause errors in the measurements, the method of support shown in the sketch, Fig. 11, was adopted.

Referring to Fig. 13, a pull upon the drawbar is received upon the yoke E, moving it to the right. This is connected through the fulcrum plate to lever No. 1, fulcrumed at its lower end at f_1. Lever 1 transmits this force to lever No. 2 through the piece Q, lever No. 2 being fulcrumed at f_2. The spring V resists the movement of lever No. 2. The force from lever No. 1 is also transmitted to the second lever No. 2 on the opposite side of the dynamometer and its motion is resisted by the second spring V. The motions of levers No. 2 are com-

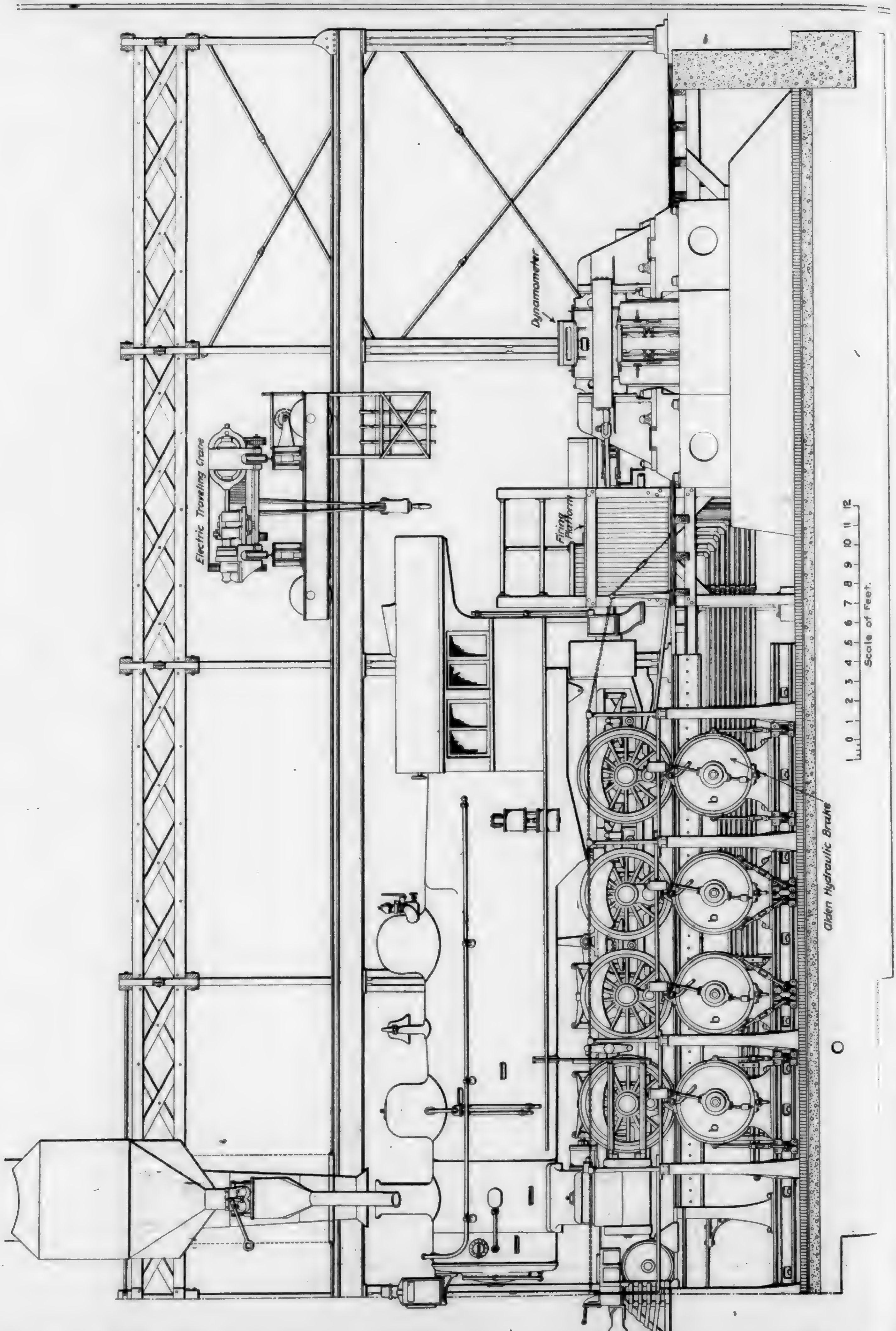


FIG. 1.—GENERAL ELEVATION OF LOCOMOTIVE TESTING PLANT—PENNSYLVANIA RAILROAD.

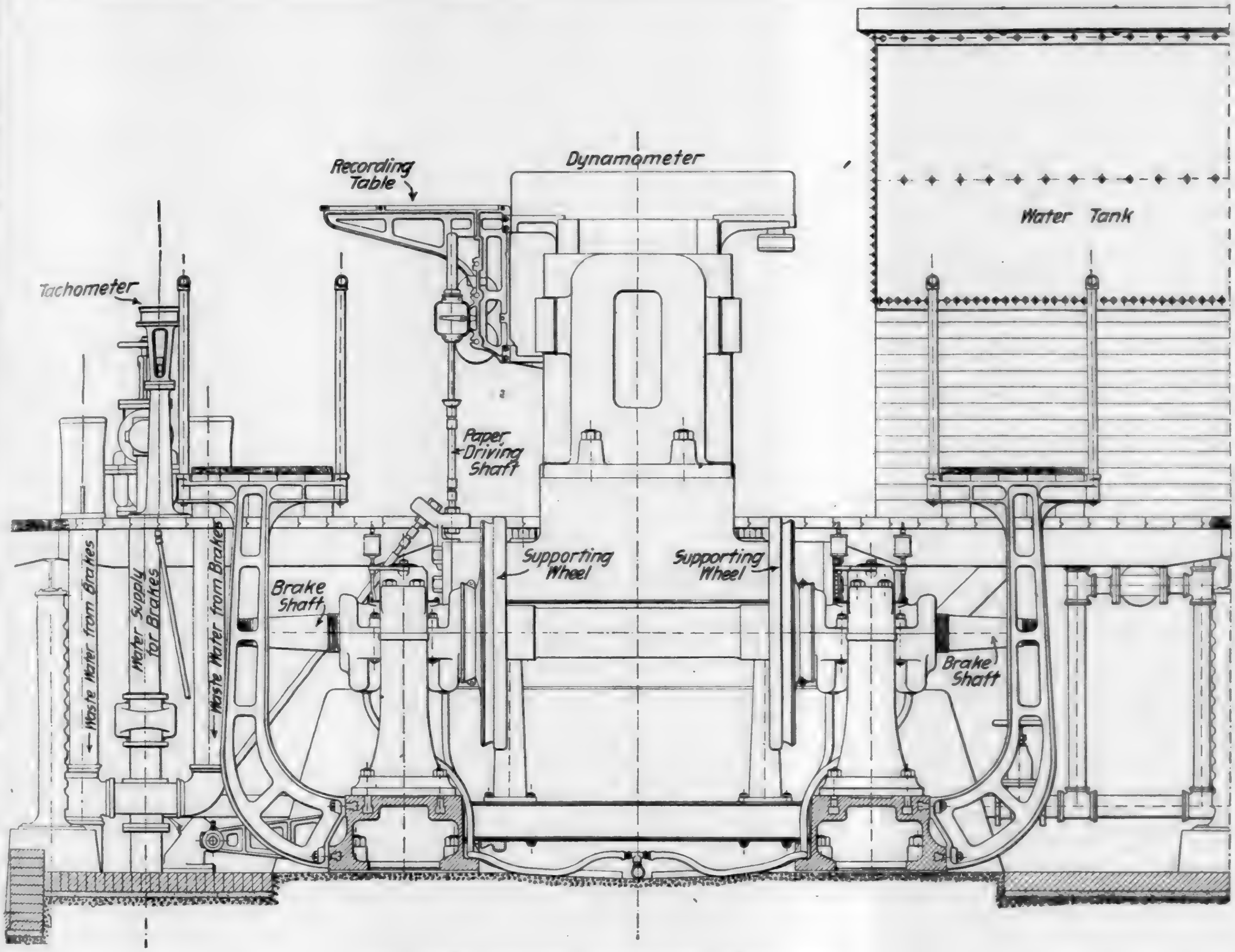


FIG. 2.—END ELEVATION OF LOCOMOTIVE TESTING PLANT.

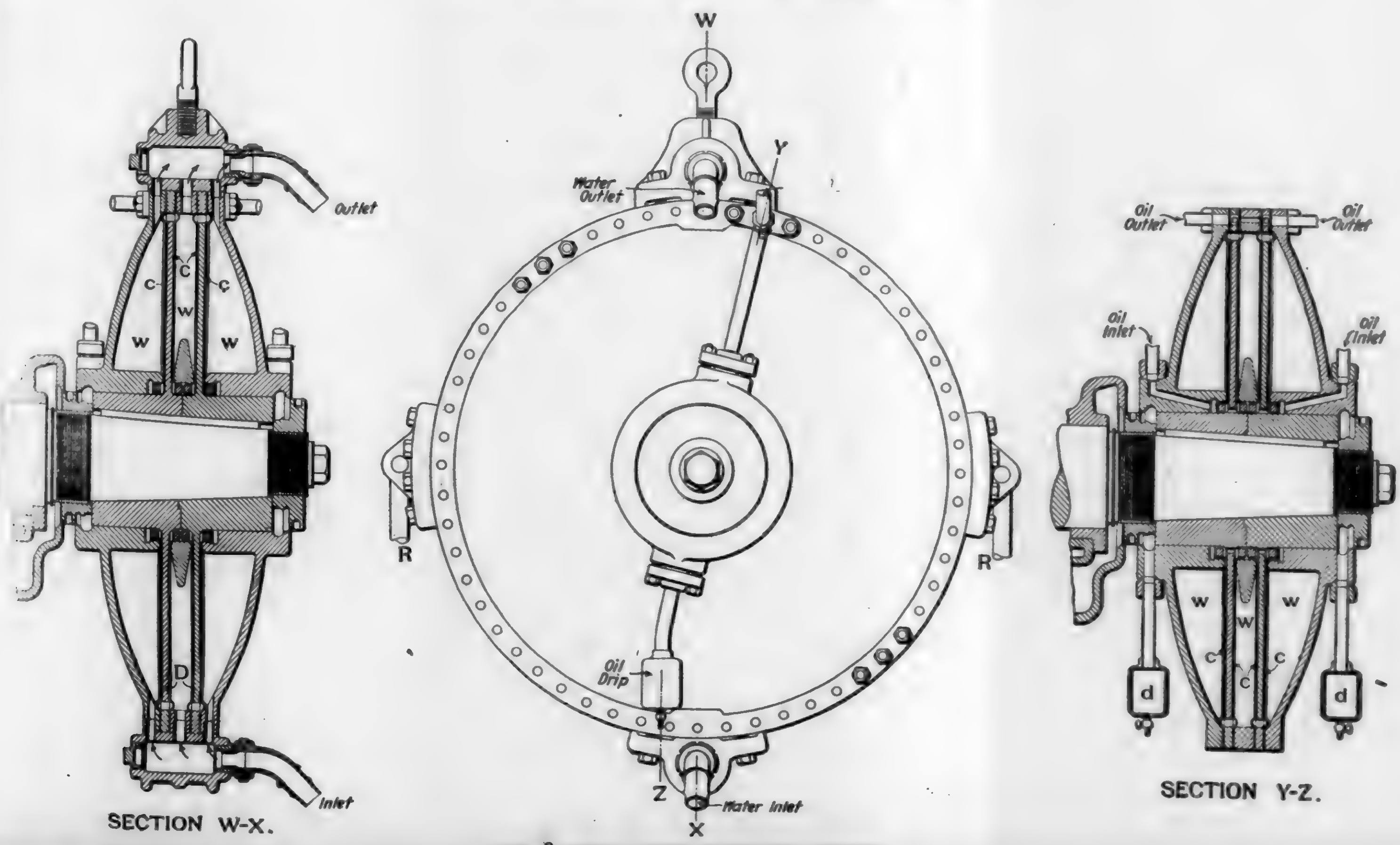


FIG. 3.—THE ALDEN HYDRAULIC BRAKE.

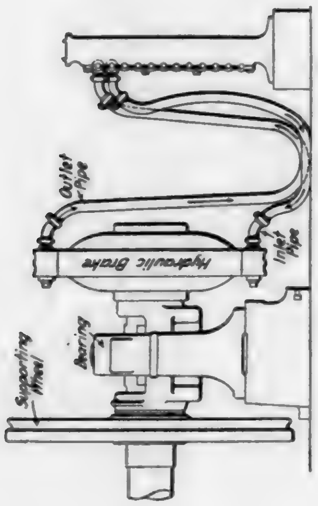


FIG. 6.—SUPPORTING WHEEL AND BRAKE.

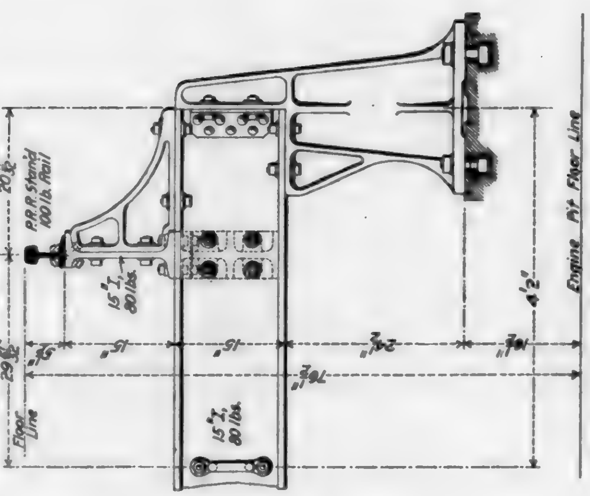


FIG. 5.—SUPPORT FOR TRUCK WHEELS.

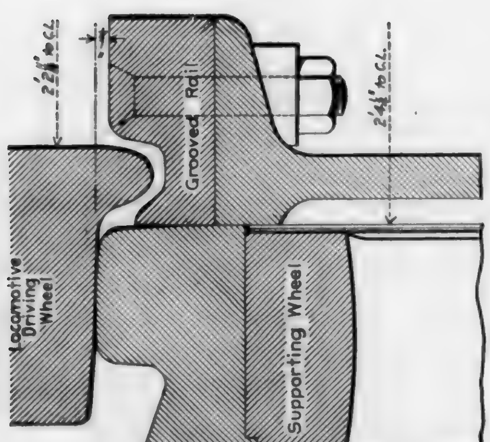


FIG. 4.—METHOD OF MOUNTING LOCOMOTIVE DRIVERS.

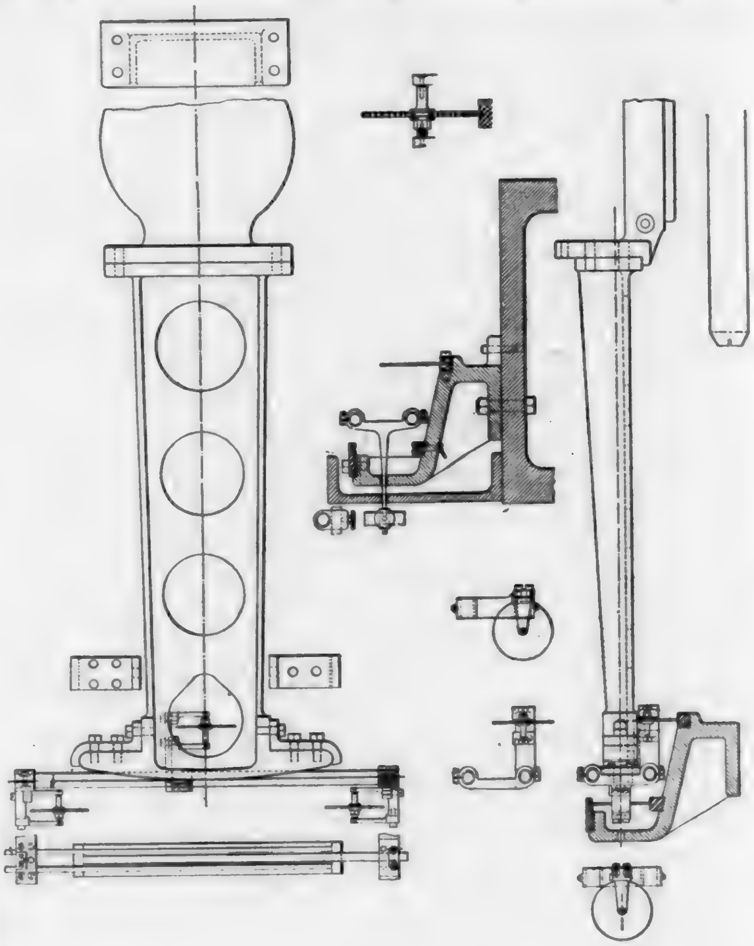


FIG. 8.—RECORDE[illegible]

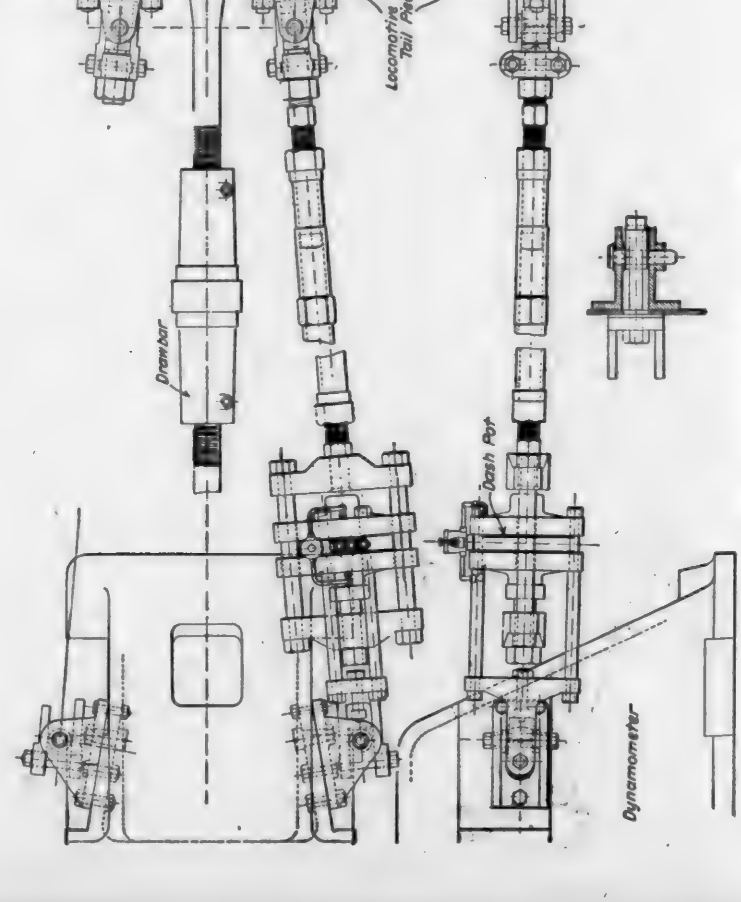


FIG. 7.—DRAWBAR AND DASH POTS.

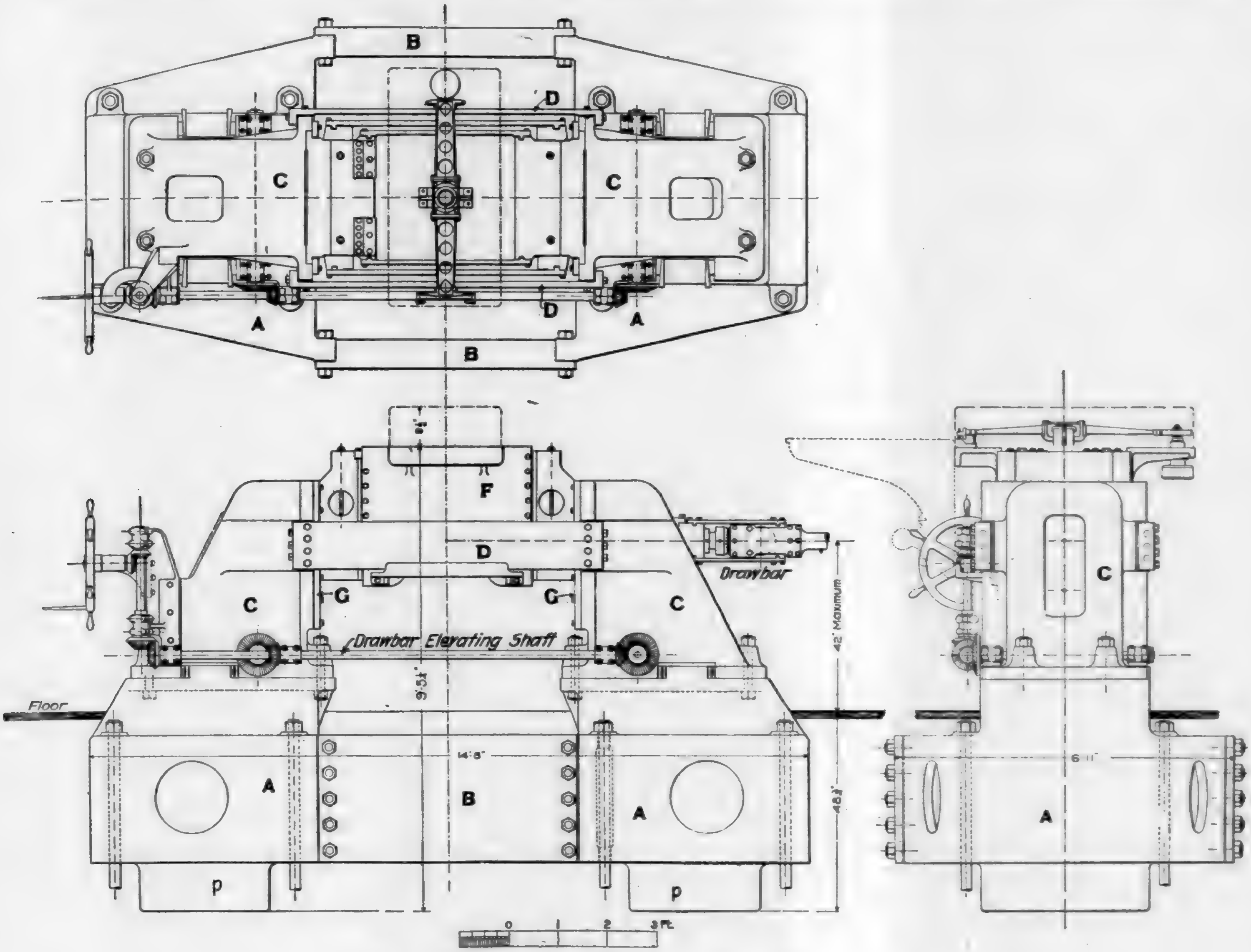


FIG. 9.—GENERAL ARRANGEMENT OF DYNAMOMETER.

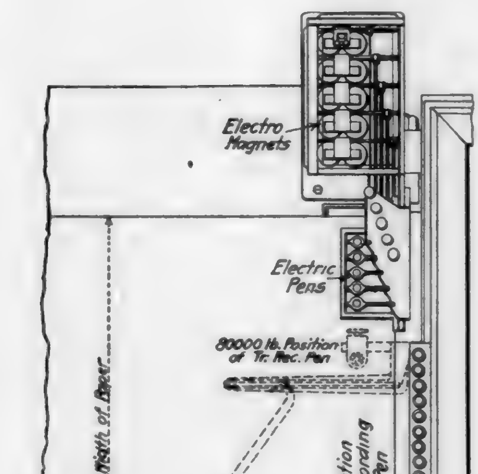


FIG. 10.—RECORDING TABLE.

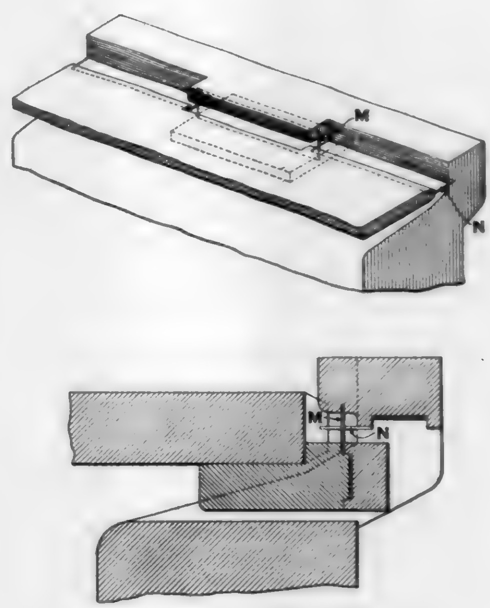


FIG. 11.—EMERY FULCRUM PLATES.

municated to the belt drum J at the bottom of the machine through the arms O, shown in the inverted plan view, from the center of the dynamometer in Fig. 13. Flexible steel bands N rotate the drum when the levers No. 2 are moved. The belt drum movement is communicated to the pen lever P by means of the tube H inside of which is the torsion rod I. The torsion rod is rigidly secured at L and it introduces additional spring resistance into the dynamometer. The plate R at the top of the dynamometer furnishes connection between

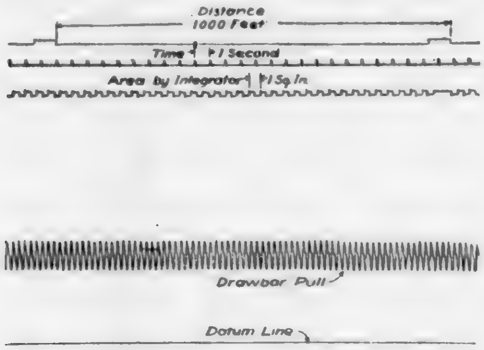
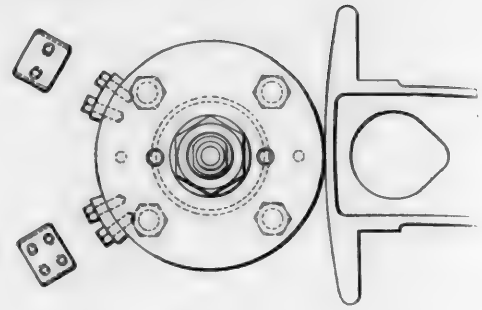


FIG. 12.—TYPICAL DYNAMOMETER RECORD.

the levers No. 2, and by means of this system of levers either a pull or a push upon the drawbar rotates the pen lever P after meeting the spring resistance already mentioned. The springs V are supplied in various capacities up to 80,000 lbs. With the 80,000-lb. springs the dynamometer records 10,000 lbs. per in., as measured from the datum line. The scale is 5,000 lbs. per in. with the 40,000-lb. springs and 2,000 lbs.



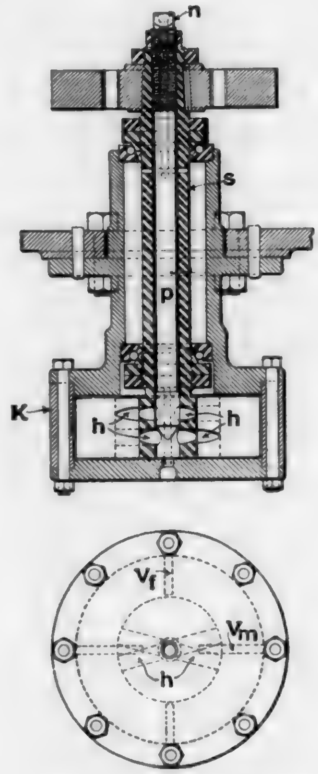


FIG. 14.—PEN ARM DASH POT.

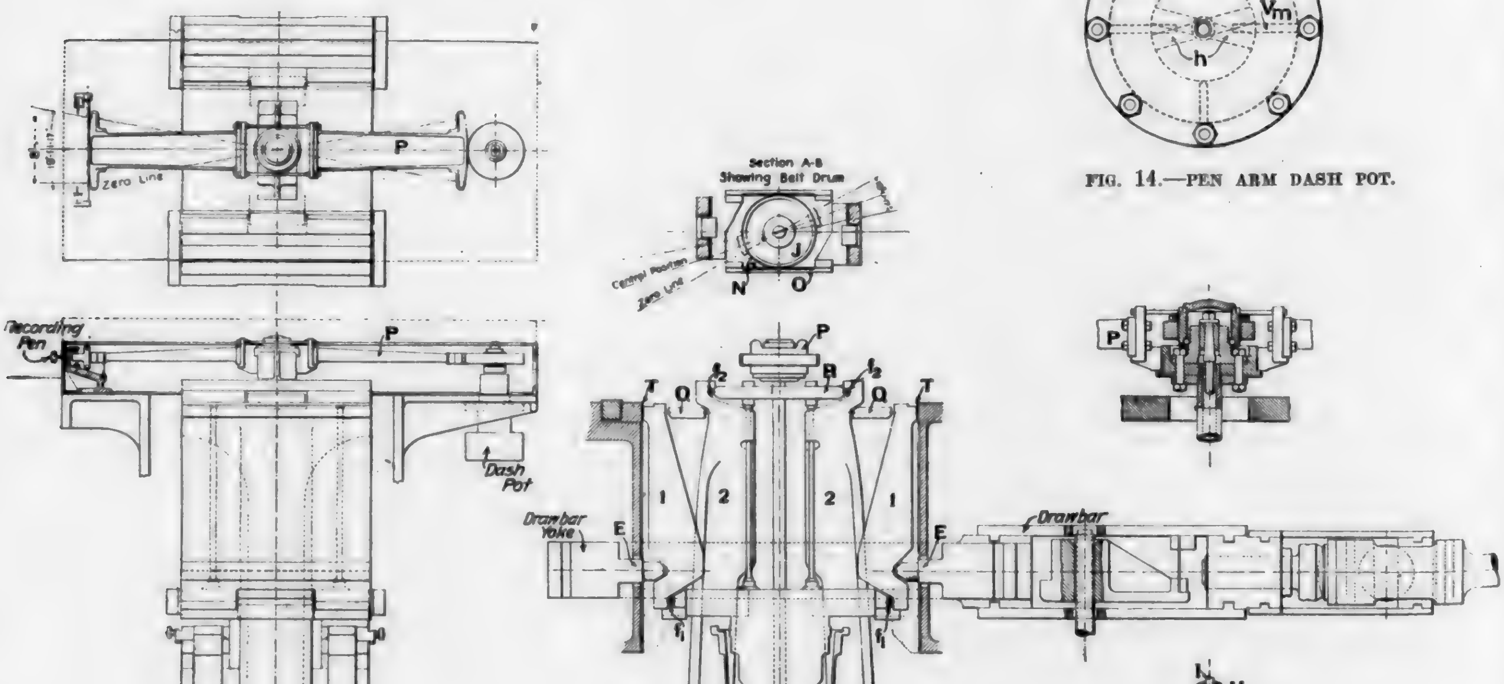


FIG. 13.—DYNAMOMETER WEIGHING LEVERS.

per in. with the 16,000-lb. springs. In these measurements the drawbar movement at the full capacity of the dynamometer is not more than 0.04 in. The recording mechanism increases this movement 200 times.

The recording mechanism, Fig. 10, is brought to a table bracketed to the dynamometer. The pen lever, Fig. 8, carries at its left hand end a segment, which, by means of steel tapes, gives to the pen carriage a rectilinear motion, the other end of the pen arm being provided with a rotary dash pot, shown in Fig. 14. In the plan view the vanes Vm are shown. These are turned in the cylinder K, being rotated by the shaft S. Fixed vanes, Vf, project from the walls of the cylinder between the center of the dash pot, the dash pot being filled with oil. Small holes, h, permit the oil to pass freely from one side to the other of the moving vanes when they are open. By turning the nut n at the top of the dash pot the holes h are partially closed and the resistance is made adjustable. Fig. 14 shows the ball bearings in the dash pot—in fact, all rotary motions in the dynamometer are made on ball bearings.

Fig. 10 shows the recording table with the datum pen, 5 electric pens, distance pen and a traction recording pen. The table mechanism was most carefully designed to insure smooth and regular motion of the paper, to reverse the direction of the driving mechanism in order to keep the paper moving in the same direction on the reversal of the locomotive, and this entire mechanism is carefully arranged so that the paper may be replaced quickly. The drawbar record is automatically integrated by the integrator shown in Fig. 10. The support for the moving paper under the integrator roller is a roller journaled under the table and the integrator roller does not wear or cut the paper. A distance marking roller records every 1,000 ft. of motion by automatic electric contacts. The recording apparatus merits a description by itself. The paper runs at the rate of 52.8 ins. per mile, giving a scale of 100 ft. to 1 in. Fig. 12 shows a sample record. A splined shaft drives the drawing rollers of the mechanism. The paper passes from the bottom roller to the top of the table, along to the outer guide roller, then to a finely corrugated brass roller, then to a calendar roll covered with rubber, and finally to the upper drum, the speed of which is sufficiently fast for all conditions. This is arranged to slip upon its shaft to take care of varying diameters of the receiving roll. The corrugated roll referred to always maintains the same relation to the speed of the support wheels.

This plant as installed at St. Louis was referred to in this journal on pages 29, 301, 365 and 400 of the volume of 1904.

A PLAN FOR MAINTAINING RAILROAD REPAIR SHOP MACHINERY.*

By M. K. Barnum.

If I were at the head of the mechanical department of a railroad and should be required to choose between an old shop fully equipped with strictly up-to-date machine tools and a new shop provided with traveling cranes and other similar modern appliances, but in which a lot of old tools were to be retained, I would unhesitatingly prefer the former as being the most efficient means of maintaining the rolling stock and the best investment of the railroad company's money.

There is one railroad whose shops a few years ago were full of worn-out and obsolete machinery, and in spite of large purchases of locomotives the conditions grew so bad that it was impossible to maintain the power in good working order; engine failures increased to three times the average on neighboring roads, and the train service became utterly demoralized. Finally an emergency existed, and as a last resort it was decided to buy some new machinery. The obsolete tools were replaced with up-to-date machines and some additions made to the equipment of all the shops, which resulted in an increase of over 50 per cent. in the output of locomotives, and that with less than a 10 per cent. increase in shop payrolls. Engine failures were reduced by two-thirds, and a steady improvement was made each month in the condition of power. Another railroad company has an old locomotive erecting and machine shop containing only 21 pits, but this shop turns out with general repairs from 45 to 50 engines a month. Whenever any machine can be replaced with one which will earn 10 per cent. or more on the investment the old one is discarded, and this practice has necessitated throwing out upwards of $25,000 worth of old machinery within the last few years, but it has also resulted in a shop well supplied with up-to-date tools and with none that are really obsolete. This shop overhauls each month from 2 to 2½ locomotives on each pit, while most other railroad shops average about one a month to each pit. It is hardly necessary to add that the management is very progressive and efficient. The same policy is followed largely in all the shops of the road under consideration, and the average cost of repairs per locomotive last year was less than $1,600, while it ranged between $2,000 and $3,000 for most other roads.

Some idea of the tenacity with which railroads cling to old machinery may be obtained from the lists below, showing the age of all the shop tools owned by two roads, neither of which can be considered an exception to the general rule:

Age of Tools.	A. B. C. R. R. No. of tools.	A. B. C. R. R. Per cent. of whole.	X. Y. Z. R. R. No. of tools.	X. Y. Z. R. R. Per cent. of whole.
Less than ten years old......	517	33	193	24
Ten to twenty years old.......	472	31	269	33
Twenty to thirty years old....	193	12	113	14
Thirty to forty years old.....	137	9	102	12½
Forty to fifty years old.....	15	1	12	1½
Not known, but very old......	211	14	125	15
Total	1,545	100	814	100

*Paper read before the Western Railway Club.

Please note particularly that 36 per cent. of all the A B C road's tools and 43 per cent. of the X Y Z road's tools are over 20 years old, while about one-sixth of the machines of each road are over 40 years old.

After a new shop is built and equipped, most railroad companies seem to think it can be operated and maintain its efficiency indefinitely without renewals or additions of machinery, but after 15 or 20 years they find the cost of work increasing and the shop output decreasing, and then they may wake up and place a big order for new machinery. One road recently bought nearly $200,000 worth of machine tools at one time for its old shops, but it would have been much better policy to buy some machinery every year, as each machine could be selected with more care and the merits of the different makes and patterns of machines could be more carefully investigated, and those chosen which were best adapted to the particular work to be done. By this plan it would also be possible to more promptly equip new machines with the small tools and special devices for holding and doing work, which are so necessary to obtain the maximum output.

Every railroad company should start a "Depreciation Fund" for maintaining the efficiency of its shop tools. Some companies now have such a fund for replacing cars and locomotives which are wrecked or worn-out, but I know of none that makes such a provision for its shop equipment.

The tools in each shop should be inventoried and valued according to their age and condition. The inventory should show for each tool the following information;

1. Location of the shop on the road. 2. Location of tool in shop —as tool room, boiler shop, etc. 3. Kind of tool and brief description. 4. Weight of tool, approximately. 5. Name of maker. 6. Date when made. 7. Present condition. 8. Original value. 9. Depreciated value—allowing 5 per cent depreciation per year until reduced to scrap value at ¾c. per lb., which would be the minimum value that should be placed on any machine.

Some machines wear out or become unprofitable to operate much sooner than others, but I believe an allowance of 5 per cent. a year is conservative and will average about right for railroad shops.

A table is submitted herewith giving the number and value of tools in six repair shops located on different roads. The names of the roads and location of shops are withheld for obvious reasons, but these are all actual figures for existing shops, which will afford a good idea as to the value of machinery in shops of different sizes; namely, those having a capacity for giving general repairs to 60, 120, 216, 300 and 600 locomotives per year, respectively. None of these shops is over 25 years old and some are quite recent, but all may be considered fairly well equipped with machinery in proportion to the amount of work to be done.

An annual appropriation of 5 per cent of the value of the machinery in each shop would practically renew it once in every twenty years and maintain it in a fair state of efficiency.

I believe the most successful manufacturers figure on renewing their machinery oftener than this—once in 10 or 15 years, for manufacturers of tools, etc., and cotton mills once in 7 to 10 years—but I do not think it necessary to renew railroad shop machinery quite so often.

Items—	Shop A. No. of tools.	Shop A. Value.	Shop B. No. of tools.	Shop B. Value.	Shop C. No. of tools.	Shop C. Value.
Machine shop	30	$16,655	50	$56,573	122	$134,975
Tin and pipe shop (includes bench tools)	12	105	11	400	48	383
Boiler and tank shop (includes furnaces, clamps, etc.)	6	750	6	5,724	36	25,680
Blacksmith shop (includes hammers, etc., but not forges)	1	1,200	5	3,746	15	14,350
Planing mill		None.	24	10,154	33	12,681
Total	49	$18,710	96	$76,597	254	$188,069
Five per cent. of total	..	935	..	3,830	..	9,403

Items—	Shop D. No. of tools.	Shop D. Value.	Shop E. No. of tools.	Shop E. Value.	Shop F. No. of tools.	Shop F. Value.
Machine shop	113	$99,043	160	$133,816	178	$196,400
Tin and pipe shop (includes bench tools)	20	2,700	42	630	55	850
Boiler and tank shop (includes furnaces, clamps, etc.)	23	21,327	23	24,450	24	48,580
Blacksmith shop (includes hammers, etc., but not forges)	13	11,957	12	15,450	25	18,500
Planing mill	57	12,383		None.		None.
Total	226	$147,410	237	$174,346	282	$264,330
Five per cent. of total	..	7,370	..	8,717	..	13,216

	Shop A.	Shop B.	Shop C.	Shop D.	Shop E.	Shop F.
Shop holds — Locomotives	5	9	16	22	22	50
Capacity — Locomotives a year	60	120	216	300	300	600
Area locomotive erecting shop, sq. ft.	..	13,163	19,688	30,000	26,532	85,854
Area machine shop, sq. ft.	..	20,837	19,687	44,600	44,220	74,605
Area boiler and tank shop, sq. ft.	..	13,320	22,620	56,730	25,232	77,503
Area — Total three shops, sq. ft.	..	47,320	61,995	131,330	95,984	237,962

By referring to the list of shops you will see that a railroad owning 200 locomotives can maintain its shop equipment in efficient condition by an annual appropriation of about $7,000, while $17,000 and $30,000 would be ample to keep up-to-date the shops of roads having respectively 600 and 1,200 locomotives. This 5 per cent. annual appropriation should not be expected to cover tools for new shops which have to be built on account of extending the road or making large additions to the rolling stock, although it might in some cases be possible to apply a part of it to such improvements. When a new shop is built and equipped the 5 per cent, annual appropriation should be allowed to accumulate until the money will earn 10 per cent. by replacing those machines which have become unprofitable to continue in use on account of wear or because of more efficient machinery having been designed.

I would advise bunching the valuation of the machinery in all the shops on any one road and applying the 5 per cent. per annum of the total for improvements in those shops where it would do the most good. This would be much better than to confine the 5 per cent. appropriation to each individual shop or sub-shop. Those tools should first be replaced which are most unprofitable to continue in service, and in buying new tools those should be selected which will effect the largest earnings. I have observed many instances where this has not been done; for example, instead of buying ordinary engine lathes, it would be more profitable for most shops to buy turret lathes, vertical boring and turning mills, automatic stud machines, milling machines, etc. Milling machines are more efficient for some work than planers and it is possible to do a great variety of work in drill presses which was formerly done in lathes and boring machines. A modern steel tired car-wheel lathe will turn out six pairs of wheels a day while some of the older machines turn out only three or less, which represents a saving by the new machine of about $2.50 per day or earnings of 20 per cent. on the investment. Modern turret lathes will do from two to five times more work than an ordinary engine lathe, and automatic stud machines will reduce the cost of studs from $2 or $3 per hundred to about $1 per hundred. Vertical boring and turnings mills will do at least double the amount of work that is possible on an engine lathe and occupy much less shop room.

Old stationary engines are often very wasteful. I remember one instance where an old engine operating a planing mill was replaced with a new one, and as soon as the latter was installed the output of the shop was increased fully 20 per cent., and the new engine, although of higher horsepower, was found to use less steam than the old one.

In most railroad shops the benefits to be derived from using high speed tool steels are largely nullified by old and light machinery.

Mr. J. M. Gledhill, in a paper presented at the October, 1904, meeting of the Iron and Steel Institute, gave some interesting examples of the work which is made possible by using high-speed tool steel. In one example a 12-inch lathe of special design and strength for rapid and heavy cutting, turned from a rolled steel bar 40 large bolts in 10 hours, removing 1¼ *tons* of metal at a speed of 160 ft. a minute, thereby saving all forging, and finishing five times as many bolts as were formerly turned by self-hardening steel in an ordinary lathe. "In fact, the cost of forging one bolt alone (formerly) amounted to more than the present cost of producing to required form 12 such bolts by high-speed machinery." In speaking of planers, he says: "The old cutting speeds of 15 to 25. ft. per minute are now replaced by those of 50 to 60 and even 80 ft. per minute, and * * * the power absorbed does not increase in anything like the same proportion as the extra amount of work done, so that the wear and tear on the machine is not materially increased." But it is safe to say that not one railroad shop in ten has a single lathe or planer capable of exerting the power and speeds which Mr. Gledhill cites as necessary to obtain the greatest economy from high-speed tool steel.

The importance of well equipped tool rooms in railroad shops seems to be very generally overlooked, and I have observed that those shops which are best managed and which turn out the largest number of locomotives in proportion to their size and the amount of machinery, are the ones which have excellent tool rooms and first-class men in charge of them.

There are railroad shops where labor unions have strongly opposed the introduction of labor-saving tools, but this is very unwise on the part of the unions, as it is on a par with the efforts made years ago to prevent the stage coach from being replaced with railroads and the old hand printing presses from being thrown out to make room for the modern power presses; in fact, this policy is a relic of the Dark Ages and should not be encouraged or tolerated. There is no occasion, whatever, for any skilled mechanic, whether union or non-union, to be alarmed about a scarcity of work, as the demand for skilled mechanics is greater than ever before. Furthermore, such efforts are bound to fail, as there is no instance in history where men have finally succeeded in opposing the march of Progress and the introduction of modern labor-saving inventions.

Two things are especially necessary in a locomotive repair shop to make the work move briskly; namely, the machine work must be turned out promptly and in sufficient quantity, and the boiler work must not be allowed to drag and delay the erecting gangs. In order to obtain these results, the equipment of the machine and boiler shops must be maintained in a high state of efficiency.

Most railroad companies go on buying engines and cars and increasing their size, but are slow to appreciate that their shops are no larger and the machinery not as good as 10 or 20 years ago when the cars and locomotives were smaller and less numerous.

Have you ever stopped to think of the amount of machinery that could be bought with the purchase price of one locomotive? Or has it ever occurred to you that if your company would reduce its last order for locomotives by one or two and use the amount so realized for new shop machinery the returns on the investment would be greater and would give more than an equivalent in engines by increasing the output of the shops and decreasing the length of time each locomotive must be held under repairs?

It is far more profitable for any railroad company to have small or medium-sized shops well equipped to crowd the work and overhaul engines promptly, than to have larger shops not so well equipped in which engines must be held from 30 to 40 days each for repairs. Take, for example, two railroads, each having shops with a capacity for overhauling 50 engines a month, one of which keeps under repairs 23 engines at a time, and is thoroughly well supplied with up-to-date machinery, so that the average time each locomotive is held in the shop for general repairs does not exceed 14 days; but the other shop, which keeps 50 engines under repairs at all times, is not so well equipped, and they are held 30 days each. The road owning the smaller well-equipped shop will have out of service for repairs but 23 engines at a time, while the company having the larger shop, not so well equipped, must keep 50 engines in the shop all the time to obtain the same output—50 locomotives a month. Therefore, the latter road will lose the service of 27 locomotives which the former has available for use, representing at a rental of $15 a day, a loss of $405 a day, or $147,825 a year. This a fair comparison, based on results obtained in actual shops.

Will it not pay every railroad company to adopt a plan for systematically maintaining its shop machinery in a high state of efficiency?

Convention Exhibits at Manhattan Beach.—Copies of diagrams of the exhibit spaces, available at the Master Mechanics' and Master Car Builders' conventions in June have been received from Mr. J. Alexander Brown, secretary of the executive committee of the Railway Supply Men. Information concerning space may be obtained from Mr. Brown, 24 Park Place, New York.

SIX-COUPLED PASSENGER LOCOMOTIVE.

4—6—2 Type—Chicago, Milwaukee & St. Paul Railway.

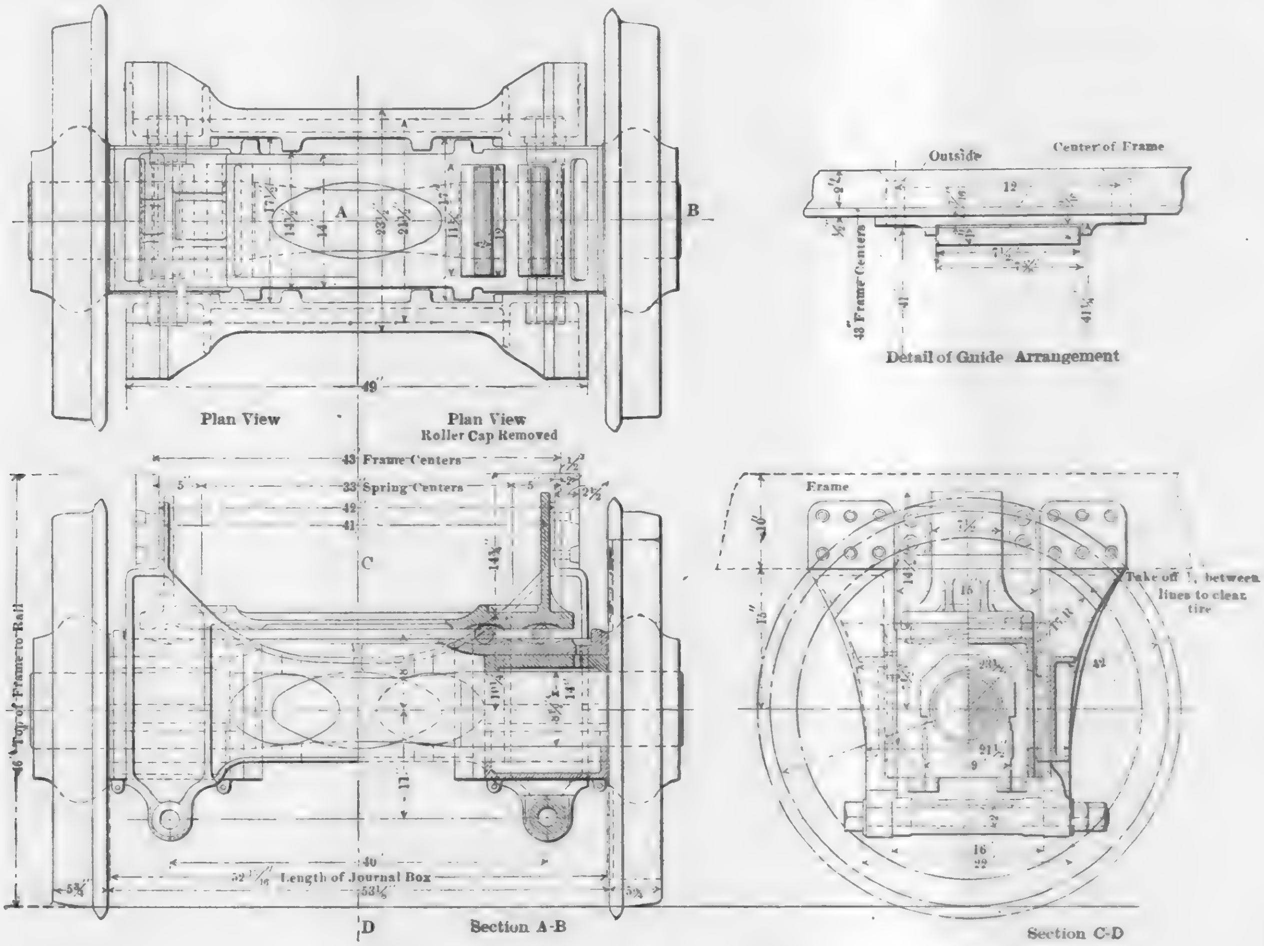
This locomotive was illustrated by a photograph on page 74 of the March number. It constitutes a departure in several respects from current practice, particularly in the narrow firebox and in the unusual cylinder proportions of 23 by 26 ins. Mr. Manchester believes the narrow firebox to possess advantages over wider ones, and is sure, from the performance of this engine, that he is correct. The tubes are much shorter than current practice in this type, and the cylinders were designed to obtain the best possible advantage in starting. Mr. De Voy, mechanical engineer of the road, has employed a ratio of 4.17 to 1 in simple freight engines, giving the same starting power as was obtained from compounds in use on this road, which have the advantage of boiler steam in the low-pressure cylinders.

The fifth design for locomotives of this road has been started by Mr. De Voy in accordance with a plan whereby the road is building all of its own locomotives. These designs are for a 19 x 26-in. switcher, a 22 by 28-in. consolidation, a 21 by 30-in., ten-wheel freight locomotive, the 23 by 26-in. Pacific type, and a ten-wheel passenger locomotive for the Kansas City division. The last-mentioned design is not yet completed.

Mr. De Voy has developed a new lateral motion, trailing truck for the Pacific type locomotive, which is, apparently, of the simplest possible construction, and is particularly novel because its principal parts are only four in number. This truck provides a lateral motion of 5 ins., and does not employ a radius bar or anything to give a radial motion. It is simply a pair of 8½ by 14-in. journal boxes placed between two jaws, the centering device being in the form of rollers. The designer has furnished a detailed statement of the cost of the truck, which is probably 50 per cent. cheaper than any form previously used and at the same time it is of strong construction.

The drawings selected for illustration show its construction clearly. The wheels are of cast steel, with spokes, and with cast iron hub liners pressed into the hubs. They are 42 ins. in diameter. The boxes are carried in a casting covering the axle between the hubs and mounted between the pedestal castings. These castings are bolted to the frames, and, incidentally, they furnish a deep brace for the rear ends of the frames. A roller cap rests on two 2 by 11¾-in. hardened steel rollers at each end, and this casting is provided with vertical brackets or lugs, engaging guide castings, which are bolted to the inside faces of the frames. This is absolutely all there is to the truck. It is reported to be entirely satisfactory in service.

The roller cap of the truck receives the load through semi-elliptic springs over the boxes, and these connect with longitudinal equalizers, the fulcrums of which are under the firebox pads. At their front ends these equalizers connect with the ends of a transverse equalizer extending across the engine in front of the ash pan.



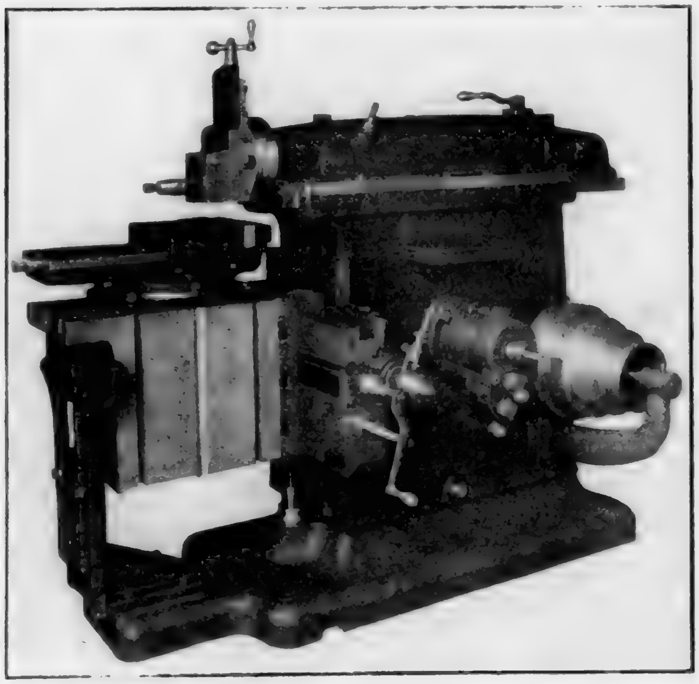
LATERAL MOTION TRAILING TRUCK FOR 4—6—2 TYPE LOCOMOTIVE.
CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

24-INCH BACK GEARED CRANK SHAPER.

The designers of the 24-in. crank shaper, illustrated in the photograph, seem to have fully understood the question of distributing the metal to the best possible advantage in order to gain strength and rigidity and also the importance of having all adjustable parts convenient to the operator and easy of adjustment. The column is of large proportions and is reinforced where the working strains are greatest. The ram gradually increases in section so that the maximum or strongest section comes into use when the cutting tool is at its extreme forward position. It has a 40 x 11-in. bearing on the column. The length of the stroke and the position of the ram may be changed without leaving the work and while the tool is at

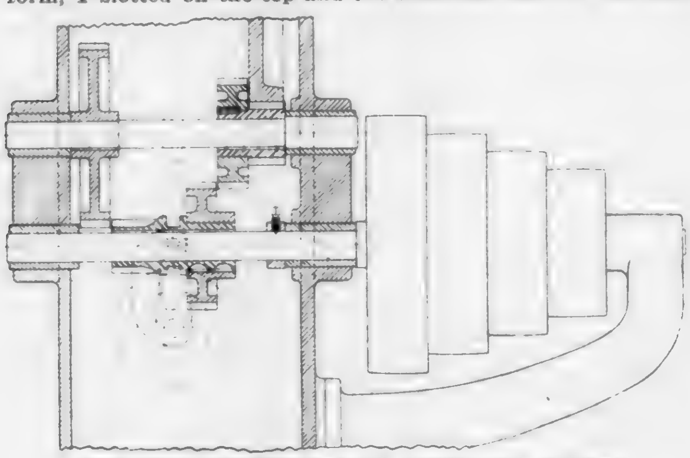
rest or in motion. A large opening under the ram provides for key seating shafts. The rocker arm is connected to the ram by means of a link which allows a straight pull and an even cutting speed, with a very quick return and no lost motion. This construction was illustrated in connection with the 16-in shaper described on page 445 of our November, 1904, journal, and the adjustment to compensate for the wear of the crank shoe was also shown.

The ratio of the back gearing is 29 to 1. A change from one



QUEEN CITY BACK GEARED CRANK SHAPER.

run of gearing to the other is made by means of a lever which operates the sliding gears on the driving shaft, as shown on the drawing. The rail is very heavy and has ample wearing surfaces. The cross traverse is 30 ins. and the screw has a graduated collar. The vertical adjustment is effected by bevel gears which are protected from chips and dust and are provided with ball bearings. A cam provides for the rapid changing of feeds without stopping the machine. The table is box form, T slotted on the top and the sides and has a V for hold-



BACK GEAR ARRANGEMENT ON QUEEN CITY SHAPER.

ing shafts and similar work vertically. It is arranged with an outer support and may readily be detached from the saddle if desired. The vise is of the planer type and its base is firmly bolted to the table; the swivel is held to this base by two steel planer head bolts. The head swivel is held in the same manner; both are graduated, and can be set at any angle, quickly and accurately. The down feed screw to the head is provided with a graduated collar. This machine is made by the Queen City Machine Tool Company, Cincinnati, Ohio, and weighs about 4,400 lbs.

A RAILROAD OFFICIAL WANTS CATALOGUES.

To the Editor:

Having been appointed general manager of the Compania del Ferrocarril de Matanzas, please state in your paper that I shall be glad to receive all kinds of catalogues and samples from firms dealing in railroad supplies and materials, addressed to me at Matanzas, Cuba.

MIGUEL C. PALMER.

WATER SOFTENING.

CONTROL AND RESULTS FROM A CHEMICAL STANDPOINT.

BY G. M. CAMPBELL, P. & L. E. R. R.

(*Continued from page* 88.)

Thus far this article has covered in a general way the system of control of the plants on the Pittsburgh & Lake Erie Railroad, and the chemical, and a few of the general, results derived therefrom. Attention will now be drawn to the more or less technical side of the treatment and the inferences to be drawn from the results.

The solutions used in testing are fiftieth normal sulphuric acid, fiftieth normal sodium hydrate, standard soap solution, methylorange indicator, one gram per liter, and phenolphthalein indicator, 5 grams per liter. The amounts of water used are such that one C.C. of the solution represents in every case the equivalent of one part of calcium carbonate per 100,000, and is called 1 deg. (this is equivalent to 0.584 grains per gal.). The "alkalinity" of any sample represents the sum of the carbonates, bicarbonates and the alkaline hydrates. The acidity, to methylorange as indicator, represents in most cases the true or free acidity of the water other than carbonic acid; the acidity to phenolphthalein as indicator, when the water is alkaline to methylorange as indicator, represents the free carbonic acid; when the water is acid to methylorange it represents all the free carbonic acid and twice the free or partly combined mineral or other acid. The relation the various tests bear to the charging may be found in the instructions for testing and treating, Tables 1 and 2. The main equations of water treating may be stated as follows:

$$(1)\quad \underset{\text{Soluble}}{\overset{\text{Bicarbonate of lime}}{CaH_2(CO_3)_2}} + \underset{\text{Soluble}}{\overset{\text{Caustic lime}}{CaO}} = \underset{\text{Insoluble}}{\overset{\text{Carbonate of lime}}{2CaCO_3}} + \overset{\text{Water}}{H_2O}$$

$$(2)\quad \underset{\text{Soluble}}{\overset{\text{Sulphate of lime}}{CaSO_4}} + \underset{\text{Soluble}}{\overset{\text{Carbonate of soda}}{Na_2CO_3}} = \underset{\text{Insoluble}}{\overset{\text{Carbonate of lime}}{CaCO_3}} + \underset{\text{Soluble}}{\overset{\text{Sulphate of soda}}{Na_2SO_4}}$$

$$(3)\quad \underset{\text{Soluble}}{\overset{\text{Bicarbonate of magnesia}}{MgH_2(CO_3)_2}} + \underset{\text{Soluble}}{\overset{\text{Caustic lime}}{CaO}} = \underset{\text{Slightly sol.}}{\overset{\text{Carbonate of magnesia}}{MgCO_3}} + \underset{\text{Insoluble}}{\overset{\text{Carbonate of lime}}{CaCO_3}} + \overset{\text{Water}}{H_2O}$$

$$(4)\quad \underset{\text{Soluble}}{\overset{\text{Sulphate of magnesium}}{MgSO_4}} + \underset{\text{Soluble}}{\overset{\text{Carbonate of soda}}{Na_2CO_3}} = \underset{\text{Slightly sol.}}{\overset{\text{Carbonate of magnesium}}{MgCO_3}} + \underset{\text{Soluble}}{\overset{\text{Sulphate of soda}}{Na_2SO_4}}$$

$$(5)\quad \underset{\text{Slightly sol.}}{\overset{\text{Carbonate of magnesia}}{MgCO_3}} + \underset{\text{Soluble}}{\overset{\text{Caustic lime}}{CaO}} + \underset{\text{Water}}{\overset{\text{Water}}{H_2O}} = \underset{\text{Insoluble}}{\overset{\text{Hydrate of magnesia}}{Mg(OH)_2}} + \underset{\text{Insoluble}}{\overset{\text{Carbonate of lime}}{CaCO_3}}$$

$$(6)\quad \underset{\text{Soluble}}{\overset{\text{Carbonic acid}}{H_2CO_3}} + \underset{\text{Soluble}}{\overset{\text{Caustic lime}}{CaO}} = \underset{\text{Insoluble}}{\overset{\text{Carbonate of lime}}{CaCO_3}} + \overset{\text{Water}}{H_2O}$$

$$(7)\quad \underset{\text{Soluble}}{\overset{\text{Sulphuric acid}}{H_2SO_4}} + \underset{\text{Soluble}}{\overset{\text{Carbonate of soda}}{Na_2CO_3}} = \underset{\text{Soluble}}{\overset{\text{Sulphate of soda}}{Na_2SO_4}} + \underset{\text{Soluble}}{\overset{\text{Carbonic acid}}{H_2CO_3}}$$

There is, among chemists, considerable discussion as to how the various impurities in water should be expressed, whether sulphuric acid, for example, should be expressed as H_2SO_4, as above, or as its radical, SO_4. Caustic lime, CaO, is used in the above equation; it would perhaps be better to use slaked lime $Ca\ (OH)_2$, but the former is retained to make the calculation for weight of lime required easier. It is rarely possible to determine the exact relation of the elements in the water. But the discussion as to the exact relation is of little importance here as the treatment is not based directly on the reactions, as given, but on the general statement that one part

of calcium sulphate or magnesium chloride, for example, not directly as such, but in whatever form it actually exists, requires one part soda. But the equations are useful just as a general method of expressing the reactions that occur. These equations need not be discussed in detail; in general sulphates, chlorides, etc., of calcium require an equivalent amount of soda ash, carbonate of soda, as in (2); bicarbonates of calcium require lime as in (1). Sulphates, chlorides, etc., of magnesium require an equivalent amount of soda ash and an equivalent amount of lime as in (4) and (5). Bicarbonates of magnesium require two equivalent parts of lime, as in (3) and (5). In most waters the bicarbonates of lime and magnesia are represented by the alkalinity. Carbonic acid is removed by lime, as in (6). Mineral acid, such as sulphuric, requires both soda ash and lime, as in (7) and (6). Carbonate of lime and hydrate of magnesia are marked "insoluble." That term is only relative. The former, freshly precipitated, is soluble to about 5 parts per 100,000, and the latter to 2 parts per 100,000. Magnesium carbonate is marked "slightly soluble," that term also is only relative; as far as treated water is concerned, it is soluble, for about 50 parts per 100,000 may be dissolved, which is far beyond the amount allowed in treated water. For each 1 deg. of alkalinity 1 part of lime is required; by one part is meant that amount of lime which is chemically equivalent to one part of calcium carbonate per 100,000, this amount is 0.56 pounds of pure lime for each one pound of calcium carbonate, or 0.66 pounds of 85 per cent. lime. The amount of 85 per cent. lime required to treat 1,000 gals. of water, or 8,330 lbs., for each 1 deg. alkalinity would be

$$0.66 \times \frac{1}{100{,}000} \times (1{,}000 \times 8.33) = 0.055 \text{ lbs.}$$

Similarly, one part of lime is required for each part of acid present, whether it is carbonic acid or mineral acid. In order to dissolve this amount of lime, 0.055 pounds, it is necessary to supply from 38 to 45 pounds, or from 4.5 to 5.4 gals. of water. The amount of water depends to a certain extent on the temperature, the solubility of lime decreasing as the temperature of the water increases. In a machine where there is always an equal head of water over the raw water and lime pipe slots, the proper supply of lime water is easily obtained by making the area of the adjustable opening in the lime pipe equal to 0.0045 to 0.0054 of the raw water slot for each 1 deg., i. e., make the areas proportionate to delivery. In practice, this area has to be slightly increased, to from 0.005 to 0.006 of the raw water slot. The permanent hardness is the difference between the total hardness and the temporary hardness or alkalinity. For each degree of permanent hardness 1 part of soda is required; this amounts to 1.06 lbs. of soda for each pound of permanent hardness present considered as calcium carbonate, or 1.116 lbs. of 95 per cent. soda. For 1,000 gals. this would be 0.093 lbs. of 95 per cent. soda for each degree of permanent hardness. Each degree of true acidity also requires 0.093 lbs. of soda per 1,000 gals. The presence of magnesium salts effects the amount of lime required; for each part of magnesium present one additional part of lime has to be added. The additional amount required may be easily found from experience, as the relative amount of magnesia in any water does not usually vary much, and it is useless to make elaborate laboratory tests to determine it. The average amount of lime used per deg. per 1,000 gals. treated, on the Pittsburgh & Lake Erie Railroad, is now about 0.056 lbs., this is somewhat under requirements; the average amount of soda is about 0.093 lbs., this is about correct.

On the weekly report sheet, Fig. 1, is a group of columns headed "Coagulant." In times of flood the rivers in the vicinity of Pittsburgh carry down an immense quantity of suspended matter, and at these times the water is very soft, often not more than 5 deg. hardness. Under such conditions there is practically no precipitate formed in the softener due to any chemical reaction, and only the heavier parts of the matter in suspension will settle, the balance will pass through the filter, giving a very turbid treated water. This is overcome by the addition of a coagulating material and a sufficient increase in the lime and soda to combine with all the coagulant added. The substances thus formed, in precipitating entangle the particles or mud with them, and so the water is clarified. It should be remembered that if the water is hard, from 10 deg. up, no coagulant is necessary no matter how much mud the water contains. It was found from experience that alum alone was entirely unsatisfactory, and ferrous sulphate, commonly called copperas, not very much better. A mixture of these substances in the ratio of about 4 pounds of ferrous sulphate to 1 pound of alum gave excellent results. On one occasion the water pumped at Pittsburgh contained about 4 per cent. by volume of mud; the treated water came out so clear that a newspaper could be read through 5 or 6 ins. of water. For each 1 lb. of the coagulant mixture, about 0.4 lbs. of soda and 0.25 lbs. of lime should be added, in addition to the amount required for treating the hardness, etc. Great care should be taken that there is sufficient soda and lime to react with all the alum and ferrous sulphate, otherwise a corrosive treated water will result. No definite rules have as yet been worked out as to the minimum amount of the coagulant that could be used; the amount will probably vary very much according to the kind of material in suspension. Very satisfactory results were obtained at Pittsburgh under severe conditions by the use of about ¾ lb. of the mixture per 1,000 gals.

The treated water is tested to determine whether or not the treatment is satisfactory. One additional test to those on the raw water is made, called "Causticity." This word was obtained from an article by Mr. A. McGill, in the *Journal of the Society of Chemical Industry*, April, 1904. With apologies to Mr. McGill, the word has been adopted, but with a somewhat different meaning. It is used in this article to mean the reading obtained in C.C. when 200 C.C. of the water are treated with fiftieth normal sulphuric acid with phenolphthalein as indicator, or, in other words, it represents alkalinity to phenolphthalein as indicator in parts per 100,000, figured as calcium carbonate. The causticity represents all the carbonates, twice the hydrates, but none of the bicarbonates. This reading may appear at first sight rather meaningless, yet it is very important, not to determine the exact condition of the water, but to determine the deficiency or excess in lime treatment. Representing hardness by H, alkalinity by A and Causticity by C, it may be proved—but the proof will not be here given, as it is a purely chemical one—that, within certain limits, in the treated water H—A = deficiency of soda and A—C = deficiency of lime; if A is greater than H there is A—H excess of soda; and if C is greater than A, C—A represents the excess of lime. Thus for each 1 deg. difference, H—A, the amount of additional 95 per cent. soda required would be 0.093 lb. for every 1,000 gals., and for each 1 deg. difference, A—C, 0.055 lb. of 85 per cent. lime. From these simple tests, treatment can be quickly and intelligently changed; but in water treating, as in everything else, it pays to make haste slowly; all other points, such as output of pumps, stoppage of supply pipes, etc., should first be investigated before any change is made in the charging tables. If it is found that the charges differ radically from the theoretical amounts above referred to, then investigation should be begun at once to find and remedy the trouble; such charges should not be allowed, even though satisfactory results are apparently obtained. There would probably be a waste of material, and probably, if the pumping rate changed, the quality of the treated water would fluctuate widely. The statements above in regard to supply of lime are not quite correct in waters containing magnesium salts. As stated before, in any water the relative proportion of magnesium salts does not usually vary to any extent, no matter how much the water as a whole varies. Consequently, the magnesia can be taken care of by obtaining experimentally the proportionate increase in lime above 0.055 lb. or by basing the proportionate increase on the full chemical analysis of a few picked samples. A method is now being developed to take care of

the magnesium directly by the regular tests, but it is not yet in shape for publication. The same holds true for acid waters; slight modifications in treatment may be made later.

For stationary plants the alkalinity should slightly exceed the hardness, and the causticity slightly exceed the alkalinity; but the latter difference should be as near zero as possible. For locomotive work it may be advisable, especially where such a device as the Raymer hot-water washing-out appliance is not in use, to keep the alkalinity slightly below the hardness and the causticity equal to or only very slightly above the alkalinity; the reason for this difference is the liability of the locomotive to foam and the increased tendency caused by the accumulative excess of soda.

In the system of tests here advocated it will probably be generally admitted that the alkalinity, acidity and causticity tests are fairly reliable, as they represent definite chemical reactions. Such, however, will rarely be admitted of the soap test. In fact, the soap test is usually looked upon as simply a rough approximation, and practically all chemists of note have so stated. Notwithstanding this adverse sentiment, the soap test, as used on the Pittsburgh & Lake Erie Railroad, has proved itself a thoroughly efficient and reliable test. Comparative tests have been made, several hundred in number, on waters of every description, with soap solutions of different strengths, and used with different quantities of water, one soap solution being the same as referred to in this article and the other made up strictly in accordance with Sutton's "Volumetric Analysis." In not one case was the difference as much as 1 part in 100,000, and in only six cases as great as ½ part in 100,000. As ½ part was the limit of accuracy aimed at, the readings were practically identical. Again, during the present year 27 samples of water were sent for full analyses, 19 to one of the best chemical laboratories in the country, the Pittsburgh Testing Laboratory, where water analysis has received great attention; the 8 other samples were analyzed by two different laboratories, both of high repute. Results obtained were as follows:

Sample No.	Full Analysis made by	Report No.	Parts per 100,000 as Calcium Carbonate. Hardness from Full Anal.	Hardness Soap Test, P. & L. E. Lab.	Diff.
1.	Pgh. Test. Lab.	21,660	19.28	18.8	— 0.48
2.	" " "	21,660	8.21	8.0	— 0.21
3.	" " "	21,661	42.08	41.4	— 0.68
4.	" " "	21,661	5.78	5.0	— 0.78
5.	" " "	21,662	4.96	5.5	+ 0.54
6.	" " "	21,662	5.12	5.0	— 0.12
7.	" " "	21,835	6.30	5.5	— 0.08
8.	" " "	21,905	55.74	55.0	— 0.74
9.	" " "	21,974	40.28	40.0	— 0.28
10.	" " "	22,066	21.20	21.3	+ 0.10
11.	" " "	22,178	93.40	88.0	— 5.40
12.	" " "	22,390	14.61	15.5	+ 0.89
13.	" " "	22,429	4.58	5.0	+ 0.42
14.	" " "	22,504	11.00	8.5	— 2.50
15.	" " "	22,898	28.38	* See note below.	
16.	" " "	22,899	6.36	5.75	— 0.61
17.	" " "	22,900	4.78	4.60	— 0 18
18.	" " "	22,982	45.97	*	
19.	" " "	22,982	2.49	1.50	—0.99
20.	Laboratory A		5.5	5.5	0.0
21.	Laboratory B	2,940	3.59	5.5	+ 1.91
22.	" "	3,031	38.1	37.0	— 1.10
23.	" "	3,224	26.85	*	
24.	" "	3,223	6.27	5.75	— 0.52
25.	" "	3,225	4.44	4.60	+ 0.16
26.	" "	3,227	49.98	*	
27.	" "	3,226	1.68	1.5	— 0.16

Samples were as follows:

No. 1. Whitsett Junction, raw water, high in magnesium salts, collected April 9th, 1904.
No. 2. Whitsett Junction, treated water, collected April 9th, 1904.
No. 3. McKees Rocks, raw water, collected April 9th, 1904.
No. 4. McKees Rocks, treated water, collected April 9th, 1904.
No. 5. Buena Vista, raw water, collected April 9th, 1904.
No. 6. Buena Vista, treated water, collected April 9th, 1904.
No. 7. McKees Rocks, treated water, collected May 12th, 1904.
No. 8. No. 3 stationary boiler, McKees Rocks, collected May 23d, 1904.
No. 9. Pittsburgh, raw water, collected June 9th, 1904.
No. 10. No. 3 stationary boiler, McKees Rocks, collected June 22d, 1904.
No. 11. Stationary boiler No. 6, McKees Rocks, collected July 27th, 1904.
No. 12. Beaver Falls, raw water, collected September 16th, 1904.
No. 13. Dickerson Run, raw water, collected September 24th, 1904.
No. 14. No. 2 stationary boiler, McKees Rocks, collected October 6th, 1904.
No. 15. Pittsburgh, raw river water, collected December 9th, 1904.
No. 16. Pittsburgh, treated water, collected December 9th, 1904.
No. 17. Groveton, treated water, collected December 9th, 1904.
No. 18. Buena Vista, raw river water, collected December 23d, 1904.
No. 19. Buena Vista, treated water, collected December 23d, 1904.
No. 20. Identical sample to No. 7.
No. 21. Identical sample to No. 7.
No. 22. Pittsburgh, raw well water, collected July 29th, 1904.
No. 23. Identical sample to No. 15.
No. 24. Identical sample to No. 16.
No. 25. Identical sample to No. 17.
No. 26. Identical sample to No. 18.
No. 27. Identical sample to No. 19.

These are a complete list of all waters analyzed to date on which parallel tests had been made, and are, therefore, not analyses picked to prove a theory.

*The two samples, 15 and 18, and their duplicates, 23 and 26, were acid waters, and the hardness tests made in the P. & L. E. R. R. laboratory can hardly be directly compared with the tests in the outside chemical laboratory. The hardness obtained in the P. & L. E. R. R. laboratory was on water neutralized to methylorange as indicator. By referring to Tables 1 and 2, it will be noted that in acid waters the charge is based on the hardness of neutralized water plus the acidity, both with reference to methylorange as indicator. For Samples Nos. 15 and 23 the P. & L. E. R. R. tests were hardness, neutralized water, 23.5; acidity, 1.5; total, for soda treatment, 25.0. Pittsburgh Testing Laboratory gave, for the same water, hardness, 22.62; and free sulphuric acid, 5.76 (considered as equivalent parts of calcium carbonate), a total of 28.38. Laboratory B gave hardness of 25.45 and free sulphuric acid 1.40, a total of 26.85. From the results obtained in P. & L. E. R. R. laboratory, and in comparison with Laboratory B, the large amount, 5.76, of free sulphuric acid given by Pittsburgh Testing Laboratory is incorrect. For Samples Nos. 18 and 26, P. & L. E. R. R. tests gave hardness, neutralized water, 32.0; acidity, 15.0; a total, for soda treatment, of 47.0. Pittsburgh Testing Laboratory gave hardness 36.33; free sulphuric acid, 9.64; a total, for soda treatment, of 45.97. Laboratory B gave hardness, 38.70, and free sulphuric acid, 11.28; a total of 49.98.

The samples tested were very varying in character, soft and hard, treated and untreated, unused and water from boilers, etc. It will be noted that, omitting Samples 15 and 18 for reasons given above, of the other 17 samples sent to Pittsburgh Testing Laboratory, the hardness as given by P. & L. E. R. R. soap test differed from that given by a full analyses by as much as 1 part in 100,000 only in Nos. 11 and 14. Both of these were boiler waters, and were extremely high in soluble sodium salts. Sample No. 19, though an unused water, was also high in soluble salts, containing about 85 parts per 100,000. These soluble salts probably affected the soap readings. Of the other 15 samples, mostly of raw or treated unused waters, in not one case was the difference between the P. & L. E. R. R. soap test hardness and that obtained by the laboratory analysis as great as 1 part per 100,000. On the other hand, attention may be drawn to the difference of 2.71 between the chemical laboratories in identical Samples Nos. 7 and 21. Laboratory A in No. 20 gave for the same water an intermediate value identical with the P. & L. E. R. R. soap test. The difference between the Pittsburgh Testing Laboratory and Laboratory B in Samples Nos. 15 and 23 is 1.53; in Nos. 16 and 24, 0.09; in Nos. 17 and 25, 0.34; in Nos. 18 and 26, 4.01; in Nos. 19 and 27, 0.81.

It is not here claimed that the soap test is an absolutely correct method of determining hardness, but it is claimed that for purposes of water softening it is perfectly reliable and will give uniformly consistent results. The variation of 1 part per 100,000, even though it is a high percentage of a low hardness, is immaterial.

A sample of water of no matter what hardness, within reasonable limits, can be taken, and repeated tests for hardness by the soap test will give identical results or almost so, and after a short experience the results obtained by any water softener attendant are almost identical with those obtained by the more expert chemist in the laboratory. It requires only a small experience to distinguish and avoid the false lather made by magnesium salts. On the other hand, the discrepancy between two different laboratories is often very marked. The accuracy and reliability of the soap test is vital to the general system of treating set forth in this article, and from

statistics such as the above, it would seem that it is deserving of the highest confidence.

The value of any system of treatment must necessarily be judged by results. After the introduction of the "clear indicator" (phenolphthalein) tests in June, 1904, the results obtained were excellent. At this time, February, 1905, practically identical formulæ are in force at all points, no matter what the source of supply or what the quality of the water, and the resulting waters are almost identical, except, of course, in the amount of soluble sodium salts. At four of the plants there are two sources of supply, each differing radically in quality. Each source may be and has been used several times in a week, and yet the resulting treated water remained practically constant.

If, then, waters of widely varying quality, whether well water or pond water or water from half a dozen different rivers, if radically different waters from different sources can be used in the same softener, alternating even daily, if one and the same softener can satisfactorily treat water varying from 5 to 60 deg. in hardness and from an alkaline to an acid water, if all these varying conditions can be handled at all points by identical treatment per degree per 1,000 gals., and if almost identical results can be obtained in regard to hardness, alkalinity and causticity, and since these conditions and results do exist on the Pittsburgh & Lake Erie Railroad, then it seems a fair assumption that the theory of the treatment here advocated and employed is worthy of confidence, that the method of control is efficient and easy of operation, and that water softening, in a softener of good design, can be satisfactorily handled by ordinary workmen who have absolutely no knowledge of chemistry.

On account of the confidence placed in the system of testing, advocated in this article, it was not thought necessary to have any complete analyses made of water at water softening points between June and December, 1904, and then only of a few waters for record purposes. The confidence placed in the system of testing is shown by the fact that water from six out of the ten softeners—Williamsburg, Groveton, Stobo, Rock Point, New Castle Junction and Haselton—all variable waters, has not yet been analyzed, but at the same time there is no doubt whatever about the quality of the treated water

Some of the samples in the early part of the year are not satisfactory according to present standards. It was not until June that a full system of tests was used, and it was somewhat later before proper adjustments were obtained, owing to some mechanical changes being made in the softeners.

Many sample analyses cannot be given, for the reason that they have not been made; nor are they necessary, for the approximate analyses, as obtained by the system of tests as outlined in this article, give all the required information, and besides give a very close estimate of the exact substances in the water. Information along this line will be published later. As samples, however, of the results obtained, raw and treated waters from Buena Vista, Nos. 18 and 19, and treated water from Groveton, Sample No. 25, are given below; the latter sample is a sample of treated water from raw water, of which no full analysis has yet been made, and yet a better treated water it would be hard to obtain.

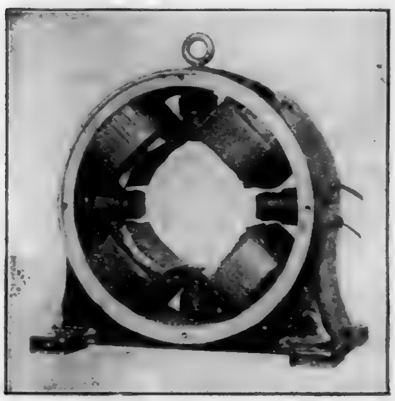
Sample No. 18. Buena Vista Raw and Treated Water.

	Parts per 100,000. Raw.	Treated.
Silica	0.88	0.52
Sulphate of alumina	12.54	0
Sulphate of iron	5.43	0
Carbonate of lime	0	0.89
Carbonate of magnesia	0	1.34
Carbonate of soda	0	4.35
Sulphate of soda	9.00	75.30
Sulphate of lime	22.27	0
Sulphate of magnesia	6.45	0
Chloride of soda	2.97	3.13
Free sulphuric acid	9.44	0

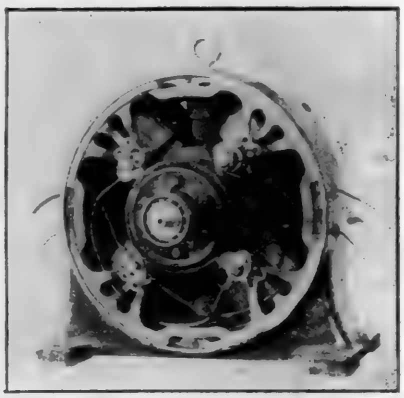
Sample No. 25. Groveton Treated Water.

	Parts per 100,000.
Calcium carbonate	2.49
Calcium sulphate	0
Calcium chloride	0
Magnesium carbonate	1.51
Magnesium sulphate	0
Magnesium chloride	0
Iron and alumina	0.21
Silica	0.65
Suspended matter	0
Sodium sulphate	12.65
Sodium chloride	6.02
Sodium carbonate	0.46
Sodium nitrate	0
Carbonic acid	0

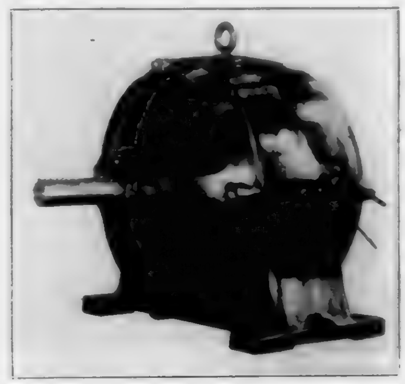
The softeners, laboratory, records, and general system on the Pittsburgh & Lake Erie Railroad are open for inspection to any one desiring information along these lines.



FRAME OF MOTOR SHOWING MAIN AND INTERPOSED POLES.



MOTOR WITH FRONT REMOVED AND ARMATURE BRUSH HOLDER RING, WITH BRUSHES IN POSITION.



THE COMPLETE INTERPOLE MOTOR.

INTERPOLE VARIABLE SPEED MOTOR.

The value of the variable speed motor for machine tool drives is indicated by the growing demand for such motors and by the improvements and new designs which are being brought out from time to time. The most recent type of this motor which can be operated on a single voltage is known as the interpole variable speed motor, and the following advantages are claimed for it: Wide range of speed, nonsparking under overloads as high as 100 per cent., practically constant speed under any load for any controller point when once adjusted, it may be reversed under full load and will run equally well in either direction, compactness of design, light weight and high efficiency at all speeds.

The auxiliary poles, which are quite small compared to the main poles, as will be noted by reference to the photograph, are located between them, and are provided with coils connected in series with the armature, so that all of the current taken by the armature flows through the coils of the auxiliary field, which are so proportioned and arranged as to give the proper field for commutation. Weakening of the field of commutation by an increased load is thus prevented, and the auxiliary poles produce the required compensatory field of commutation independently of the main field, which, with an increased number of revolutions of the armature, must be correspondingly weakened. Sparking due to armature re-

action and to self-induction in the armature coils, which are short-circuited at the instant that their corresponding commutator segments pass under the brush, is thus avoided, and it is not necessary to shift the brushes in order to reverse the motor.

The torque of these motors increases as the speed decreases, and the horse-power capacity is therefore not effected by the speed. The construction is simple, and, owing to the absence of sparking, the cost of maintenance should be low. The field yoke or frame is of cast steel. The armature shaft is of large diameter, and is fitted with Hess-Bright ball bearings. One ball race is pressed on the end of the armature shaft and the other fits in the bearing housing. The balls are separated by springs. This type of ball bearing has been in use on motors in Europe for three years with excellent results. By their use friction is greatly reduced, the length of the motor may be made much less than where the ordinary type of bearing is used, and as vaseline is used for lubrication, there is no danger of getting oil on the commutator and coils.

The construction and lubrication of the motor are such that it can be placed in any position. The speed range ordinarily furnished is either 2, 3 or 4 to 1, but greater variation can be provided, if desired. These motors are made by the Electro-Dynamic Company of Bayonne, N. J.

LOCOMOTIVE DRIFTING VALVE.

WABASH RAILROAD.

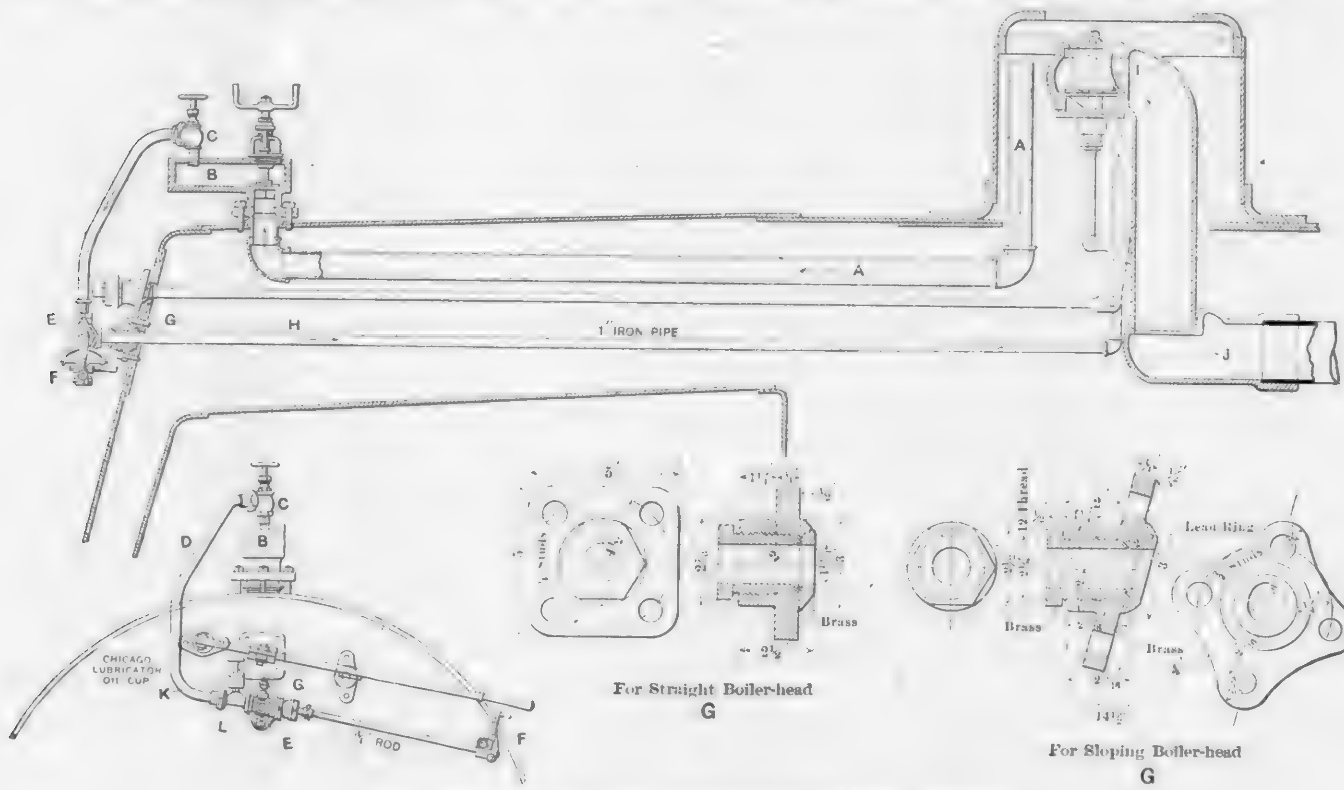
This device was developed to prevent the formation of vacuum, and compression when drifting and incidentally to improve lubrication and reduce repairs. It has been in service for a year and has been applied to more than 150 Wabash locomotives. Relief valves on slide valve engines and by-pass valves on compounds and piston valve engines have been discarded. The effect of the drifting valve on the wear of brasses has been marked. Its effect in reducing cylinder retardation in drifting is also marked. This device is also fitted with an oil cup attachment whereby the valves and cylinders may be lubricated in case of a failure of the regular lubricating cup or the attachment may be used for introducing graphite.

In the engravings A is a steam pipe leading from the steam dome to turret B, to which is attached a globe valve C, connecting with a drifting valve E by pipe D. Valve E is operated by a handle working in quadrant F, which opens or shuts valve E. To valve E is attached pipe H, running through stuffing box G. Pipe H is connected with the throttle box at I. The object is to take dry steam from the dome, as indicated by the arrows, and introduce it into the cylinders through the connections mentioned and dry pipe J. Globe valve C regulates the supply of steam from turret B and the engineer controls the steam by handle F through the drifting valve E. When the engine is running or drifting with the throttle valve closed, the position of the reverse lever need not be disturbed. While the engine is in motion the drifting valve is open and when the engine is standing at stations the valve is shut. The operation of this valve relieves compression, it destroys vacuum, keeps the engine running smoothly without reaction, making a great reduction in repairs. The suction of smoke and cinders into the steam chests and cylinders and the consequent cutting of valve seats and cylinders is corrected. It is also reported to prevent the metallic packing from being knocked down and broken.

An oil cup K is used for oiling the main valves of the locomotive while drifting in case of failure of the lubricator. To operate the cup, close valve C and open cup K and oil will be drawn into the steam chests and cylinders by suction.

While the engine is standing, the valve C is closed, the cup K opened and the pipe H filled with oil, then cup K is closed, the valve C opened and oil will be immediately carried into the steam chests and valves by steam pressure from the boiler. L is a nipple providing a convenient place for the attachment of the cup K, being so designed that the oil cup may be always tapped in vertically.

This information was furnished by Mr. J. B. Barnes, superintendent of motive power of the Wabash Railroad.



NEW DRIFTING VALVE FOR LOCOMOTIVES—WABASH RAILROAD.

PLANER WITH PNEUMATIC REVERSING MECHANISM.

The belt shifting mechanism has not proved very successful for reversing the platen on the larger planers, especially since higher cutting and return speeds have been attempted. The 96 in. by 96 in. by 20 ft. Sellers' planer, illustrated herewith, weighs 60 tons, has a cutting speed varying from 15 ft. to 45 ft. a minute, a constant return speed of 80 ft. a minute, and is equipped with a pneumatic reversing mechanism, which does away with the belt shifting mechanism, affords a quick

and uniform reverse and reduces the loss of power at reversal due to the inertia of the rotating parts. The planer is driven by a 50-h.p. motor placed on a cast iron platform supported by brackets on the housings. It is provided with two cutting tools on the cross rail and one on each of the housings. Each of the two saddles has its own feed motion, independently adjustable in direction and amount. Each has also its own stopping and starting device, but the planer is so arranged that all of these may be thrown out of action or into action simultaneously by the motion of a hand lever, and this may be done from either side of the planer. The table is supported in one flat and one V-bearing, which are lubricated by oil under pressure instead of through rollers or wipers. The oil is circulated through a piping system by a pump, and returns to the oil tank through filters. The V-bearing has four surfaces, two forming a V of large angle sufficiently inclined to guide the table under ordinary circumstances, but having the minimum wedging action. The other two surfaces are nearly vertical, and do not bear under ordinary circumstances, but are ready to resist side cuts which are sufficiently heavy to slide the table up on the V. This arrangement permits the table to run lightly under ordinary work, but prevents it from lifting under any condition of heavy side cutting.

Details of the clutch and driving mechanism are shown in Fig. 2. A spiral pinion on the shaft P drives the table. The spur gear C on the outer end of shaft P is driven by the spiral pinion N on the pulley shaft. The driving pulley A runs loose on the shaft K, and is driven continuously and in the same direction while the planer is in operation. Pinion B, which is keyed to the hub of pulley A, drives through gears C, D, E and F the gear G, which runs loose on the shaft K and in the opposite direction from pulley A. J and M are bolted together, forming an air-tight cylinder, free to move back and forth on the disk H, which is keyed and pinned to the shaft K. To compel the shafts to rotate with the friction clutch the head of the cylinder J is provided with notches into which teeth on the surface of the piston H project. These form a jaw clutch, and permit end movement while they compel the parts to move together.

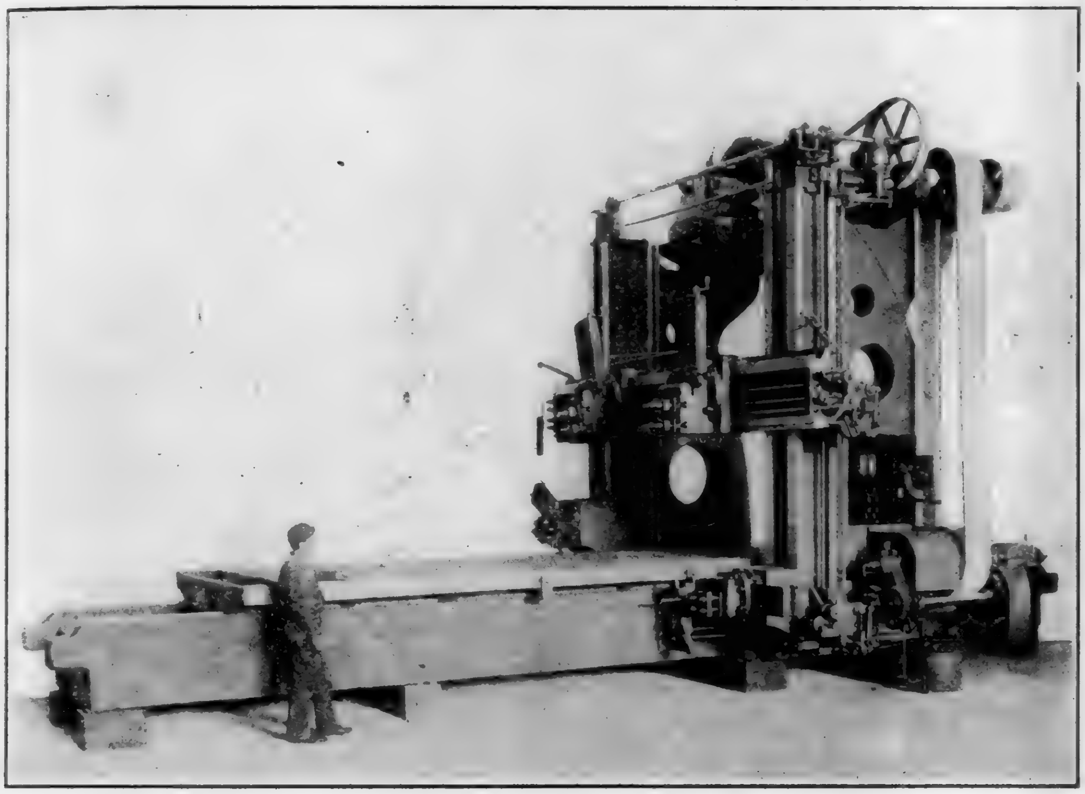


FIG. 1.—SELLERS' PLANER, WITH PNEUMATIC REVERSING MECHANISM.

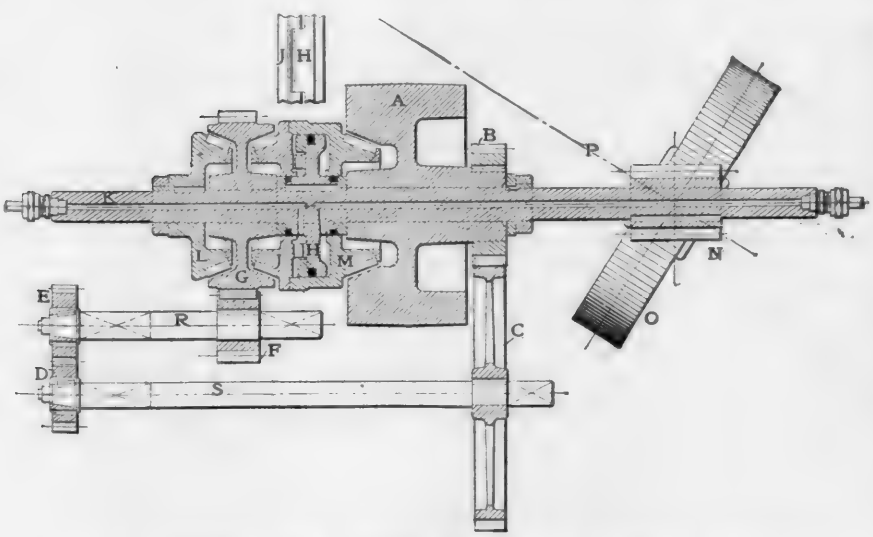
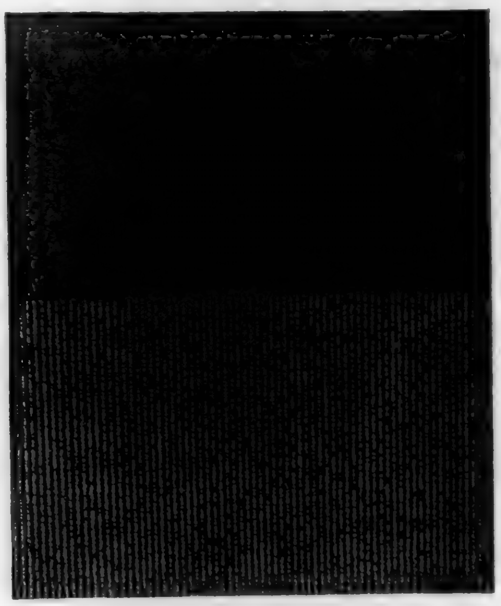


FIG. 2.—SECTIONAL VIEW, SHOWING DRIVING AND REVERSING MECHANISM.



SAMPLE OF PLANING, SHOWING UNIFORMITY OF REVERSE.

Air admitted to one end of the cylinder through the center of the shaft K, between the parts H and M, causes the cylinder to move in the direction of the pulley A, pressing the friction cone against the pulley, so that the clutch rotates with the pulley. This movement is transmitted through the piston H by the clutch teeth, and causes the shaft to rotate in the same direction, which gives the return movement of

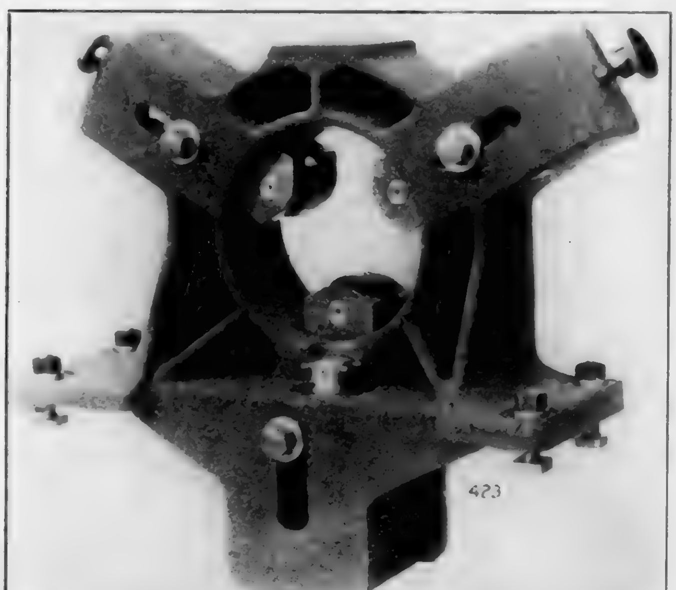
the table. Admitting air to the opposite end of the shaft causes the clutch J to engage with the wheel G, forcing the latter against the stationary clutch L, which is keyed to the shaft so that the wheel G drives the shaft through both of the clutches, one on either side in the proper direction for cutting at a speed which may be varied by changing the gears E and D. These are mounted on split bushings with conical holes, which permit the gears to be shifted with little trouble. In the operation of the planer the table stops move an air valve, which admits compressed air alternately to the opposite ends of the cylinder, and by regulating the velocity of the admission the speed of the reverse can be nicely gauged. It is arranged so that the table is brought to rest promptly and started up in the opposite direction without shock. There is no reversal of high speed pulleys, and the flywheel action of the parts whose motion is reversed, owing to their relatively small size, is unimportant. Fig. 3 shows a casting which was first planed on one edge with a heavy roughing cut, the tool being held in one of the side heads. A square nose finishing tool was then substituted and the stroke shortened, so that the cut terminated within the surface of the casting. The stopping point of the successive finishing cuts occurred in a practically true vertical line, and illustrates the uniformity of the reverse.

A separate belt is used to actuate the lifting gear and drive the feed motion. The latter is accomplished through a positive motion clutch, which is stopped and started at each reverse of the table. The side heads are lifted by the same screws which carry the cross rail. These screws are stationary under ordinary circumstances, and the heads are raised and lowered by rotating nuts.

The cross rail is secured to the uprights in such a way that the full strength of the housings is brought into play to resist the torsion of the cross rail, and at the same time the cross rail stiffens the housing against the twisting action of the side heads. This allows unusually heavy cuts to be taken. In some 54-in. planers of this construction two cuts of 60,000 lbs. each were taken in steel without any perceptible spring of the cross rail, although it was scarcely larger than is usually provided for a planer of that width.

HIGH SPEED FOLLOWER REST.

In order to obtain the best results in rough turning bars even as large as 8 ins. in diameter with high speed steel, experience has demonstrated that a substantial support or follower rest is necessary. The Lodge & Shipley Machine Tool Company, after trying several different metals for the jaws of such a follower rest, only to have them cut out, have adopted rollers, as shown in the photograph. These rollers are of hardened steel, and are mounted upon hardened and ground steel shafts, upon which they are fixed by screws through the face of the rollers. Liberal oiling facilities are provided for the journals of the roller shafts. In order that the jaws cannot be forced down too tightly, a sensitive adjustment is provided by the knurled knobs.



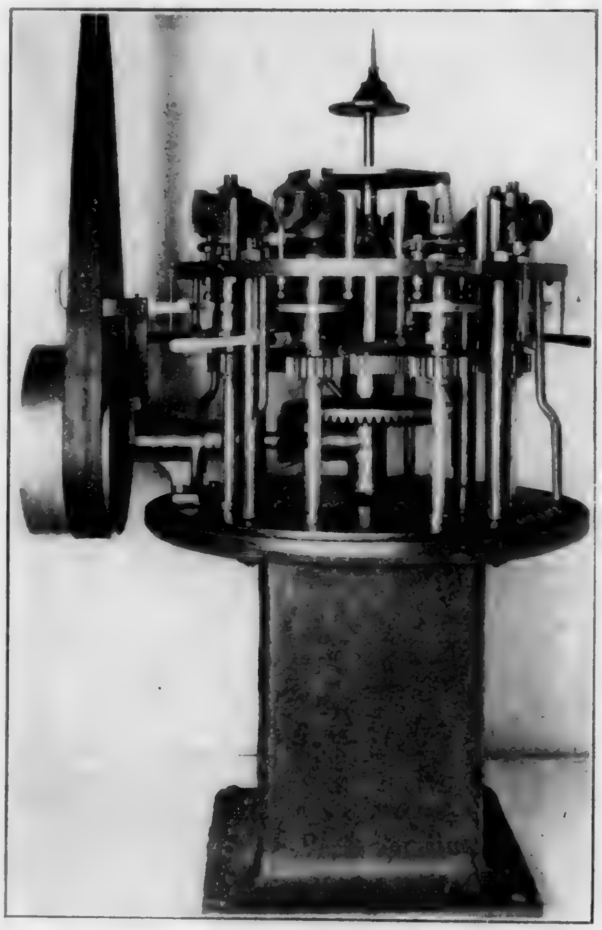
HIGH SPEED FOLLOWER REST—LODGE & SHIPLEY MACHINE TOOL COMPANY.

To insure still greater stiffness and rigidity the pad at the top may be planed, and by means of an angle bracket be connected to the wings of the carriage on the opposite side. It is claimed that double the output may be obtained on heavy bars on one of the company's high speed lathes with this device over that which may be obtained on the same lathe without a rest.

AUTOMATIC VALVE GRINDING MACHINE.

This machine was designed to facilitate the manufacture and repairs of the cut out and angle cocks used in connection with air brake apparatus but may easily be arranged to grind any plug valve or valves with disc seats such as are used in general practice. It is claimed that an eight spindle machine will grind from 200 to 400 old cocks or from 500 to 600 new ones in 10 hours and that very much better work is done by machine than by hand grinding.

The valve to be ground in is fastened to the end of one of


AUTOMATIC VALVE GRINDING MACHINE.

the spindles and the body of the valve is simply placed on the valve and is kept from revolving by the uprights or columns which are placed at either side of each spindle. No force other than the weight of the body is required to hold the two parts together while they are being ground. By means of the cam placed just above the spur gear on each spindle the body is lifted off the valve twice during each revolution of the spindle. Each spindle may be stopped or

started independently of the others by means of the jaw clutches.

An eight spindle machine, such as the one illustrated, weighs about 1,000 lbs. and occupies less than 4 sq. ft. of floor space. In addition to the eight spindle grinder the Automatic Valve Grinding Machine Company of Knoxville, Tenn., also make four and six spindle machines.

VAUCLAIN BALANCED COMPOUND LOCOMOTIVE.

FRISCO SYSTEM.

Information received since the publication of the description of the 4-cylinder Vauclain balanced compound locomotive of the Chicago & Eastern Illinois, on page 97 of the March number, indicates that instead of the weights given the actual weights are:

On trucks	45,800 lbs.
First pair of drivers	48,800 lbs.
Second pair of drivers	46,500 lbs.
Third pair of drivers	49,960 lbs.
On all drivers	145,260 lbs.
Total weight	191,060 lbs.

PERSONALS.

Mr. A. H. Gairns has been appointed master mechanic of the Colorado & Southern Railway at Cheyenne, Wyo.

Mr. J. J. Connor has been appointed general foreman of the Houston & Texas Central at Houston, Texas.

Mr. A. J. Poole has been transferred as master mechanic of the Seaboard Air Line, from Savannah to Atlanta, Ga.

Mr. H. M. Muchmore has been appointed master mechanic of the Paris & Great Northern, with headquarters at Paris, Tex.

Mr. C. E. Gossett has been appointed master mechanic of the Chicago, Rock Island & Pacific with headquarters at Eldon, Mo.

Mr. William Lincoln has been appointed master mechanic of the Northern Pacific at Staples, Minn., to succeed Mr. H. M. Curry, promoted.

Mr. George Holden has been appointed master mechanic of the Texas & New Orleans Railroad with headquarters at Beaumont, Texas.

Mr. W. P. Sproul has been appointed master mechanic of the Atlantic Coast Line at Savannah, Ga., to succeed Mr. F. S. Anthony, resigned.

Mr. Jacob Schilling has been appointed master mechanic of the Chicago, Peoria & St. Louis Railway, with headquarters at Peoria, Ill.

Mr. Thomas Nichols has been appointed machine shop foreman of the Baltimore & Ohio at Lorain, Ohio, to succeed Mr. W. F. Ryan.

Mr. F. Burke has been appointed travelling engineer and airbrake instructor of the Duluth, Missabe & Northern, with headquarters at Proctor, Minn.

Mr. S. T. Park has been appointed acting superintendent motive power of the Chicago & Eastern Illinois, with office at Danville, Ills. He has been master mechanic of that road.

S. Milliken has been appointed superintendent of motive power of the Houston & Texas Central, with headquarters at Houston, Texas, to succeed Mr. S. R. Tuggles, resigned.

L. L. Collier has resigned as master mechanic of the Newton & Northwestern to become general foreman of the Chicago, Rock Island & Pacific shops at Dalhart, Texas.

Mr. J. E. Gould has been appointed master mechanic of the Chicago, Rock Island & Pacific at Goodland, Kan. He was formerly master mechanic of the Cincinnati, Hamilton & Dayton.

Mr. R. L. Langtim has resigned as mechanical engineer of the Denver & Rio Grande to become mechanical engineer of the Cincinnati, Hamilton & Dayton, with headquarters at Lima, Ohio.

Mr. H. M. Curry has been promoted from the position of division master mechanic of the Northern Pacific at Staples, Minn., to that of general master mechanic, with headquarters at St. Paul, succeeding Mr. A. W. Wheatley.

Mr. William Cockfield has been appointed locomotive superintendent of the Mexican Railway, with headquarters at Orizaba, Mexico, to succeed Mr. J. M. Muir, resigned. Mr. Cockfield was formerly locomotive superintendent of the Interoceanic Railway of Mexico.

Mr. George W. Smith has resigned as superintendent of motive power of the Chicago & Eastern Illinois to become superintendent of machinery of the Missouri Pacific Railway, with headquarters at St. Louis, succeeding Mr. J. W. Luttrell, resigned.

Edward Longstreth, who was for a number of years general superintendent of the Baldwin Locomotive Works, and a member of the firm of Burnham, Williams & Co., died in Philadelphia, February 24th, at the age of 64 years. He began as an apprentice in the Baldwin Works in 1857, and ten years later became general superintendent. After three years in this position he was admitted to the firm. He was one of the leaders in the development of these works, and contributed in a very important way to their success.

NEW CATALOGUES.

VALVE TROUBLES AND HOW TO AVOID THEM.—A small pamphlet from Jenkins Bros., 71 John street, New York City.

METAL SAWS.—Catalog No. 3 from the Higley Machine Company of New York, N. Y., describes the various metal saws and saw blade grinders made by them.

DRILL-GRINDERS.—Catalog C from the Washburn shops of the Worcester Polytechnic Institute of Worcester, Mass., describes the drill-grinders manufactured by them.

MILLING MACHINES.—A handsome catalogue has just been recieved from the Kempsmith Manufacturing Company, Milwaukee, Wis., which describes their line of milling machines and attachments.

COMMON SENSE AND MATHEMATICS.—In a small pamphlet, with this title, the Lucas Machine Tool Company, Cleveland, O., emphasize the advantages afforded by their "Precision" boring, drilling and milling machine.

BUDA METALS.—Bulletin No. 11 from the Buda Foundry and Manufacturing Company, Railway Exchange building, Chicago, describes their new anti-friction metals, bronzes and hardened or "steel" copper.

MOTORS.—Folder No. 4038 from the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa., describes their type F induction motor and illustrates some typical applications. Folder 4039 describes their type R direct current motors.

ALTERNATING CURRENT GENERATORS.—Bulletin No. 50 from the Crocker-Wheeler Company, Ampere, N. J., describes in detail their belt type alternating current generators, which are made in sizes from 30 to 250 K. W. A.

TRUCKS.—A handsome catalog from the J. G. Brill Company of Philadelphia, Pa., describes in detail their 27 E truck, considers the advantages to be gained by its use, and presents a number of strong testimonials and a long list of its users.

VERTICAL MILLING MACHINES.—Catalog No. 40 from the Newton Machine Tool Works, Philadelphia, Pa., illustrates several designs of vertical milling machines, both belt and motor driven, which are specially adapted for locomotive and railroad shops.

Tools and Supplies for Steam, Water and Gas Users.—A pocket catalog from the Walworth Manufacturing Company, Boston, Mass., manufacturers of brass and iron goods and tools and dealers in wrought iron pipe and supplies for steam, water and gas work.

Variable Speed Motor Drives.—Bulletin No. 37A from the Northern Electrical Manufacturing Company, Madison, Wis., considers the best types of controllers to use with variable speed motor drives for different machine tools and illustrates several applications of Northern motors.

Variable Speed Motors.—Bulletins 5, 6 and 9, series B, from the Electro-Dynamic Company, Bayonne, N. J., furnish data and dimensions of the various sizes of their inter-pole variable speed motors, describes their construction in detail and considers the most important advantages afforded by this type of motor.

Electric Motors.—Circular No. 1097 from the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., describes in detail their type K direct current, series wound motors for crane, hoisting, and similar service. Circular No. 1099 describes their bi-polar motors for direct current circuits, which are made in sizes from 1-6 to 1¾ h.p., and wound for 110 and 220 volts.

Protection of Steel from Corrosion.—The April number of *Graphite* contains an impressive number of fine engravings of notable buildings and bridges in various parts of the world, all of which are protected by graphite paints. It also contains seasonable talks on good paint and good painting. Those who are responsible for steel structures should procure copies from the Joseph Dixon Crucible Company, Jersey City, N. J.

How to Handle Water for the Locomotive.—Bulletin No. 2 from the Otto Gas Engine Works, 360 Dearborn street, Chicago, considers the methods of supplying water to locomotive tenders and describes and nicely illustrates their stand pipe, new steel bottom tank and the various tank and water column fixtures made by them. With improved appliances water can be discharged into the tender tank at the rate of 6,000 gals, per minute.

Progress Reporter.—The April number just received from the Niles-Bement-Pond Company is devoted entirely to locomotive manufacture and contains 46 full-page half-tone illustrations showing their machines and cranes as installed at the Schenectady and the Brooks works of the American Locomotive Company. Every motive power officer should look this number over carefully, as most of the machines are adapted to locomotive repair shop work, and the methods of handling the work and the rate at which some of the parts are machined will afford the means of a valuable and instructive comparison with what is being done in their own shops.

NOTES.

Crocker-Wheeler Company.—Mr. B. A. Schroder has been transferred from the St. Louis to the New Orleans office, to succeed Mr. W. P. Field, who has gone to the Boston office.

Manning, Maxwell & Moore.—Mr. E. B. Boye has been appointed manager of the Cleveland office of this firm in Williams Block, Cleveland, O. He has been connected with the Chicago office for the past five years.

Stockbridge Machine Company.—This company announces that they have made arrangements with the Niles-Bement-Pond Company for the sole agency of their shapers in New York, Boston, Chicago and London.

The Buda Foundry & Manufacturing Company.—This company has been successful in procuring a large order for track supplies to be used in the Panama Canal work, and shipments are now being made.

American Electric & Controller Company.—Mr. Chas. D. Knight, who has been connected with the engineering departments of the General Electric Company, National Electric Company and the Cutler-Hammer Manufacturing Company, has been appointed chief engineer of this company, and under his supervision a complete line of alternating and direct current controllers, starters, automatic switches, solenoids, etc., will be manufactured in addition to the "Rheocrat." His office address is 12 Dey street, New York.

Crocker-Wheeler Company.—The Trustees of the Sanitary District of Chicago have placed an order with this company for four 4,000-k.w. 3-phase 60-cycle 6,600-volt alternating current generators with exciters.

The W. L. Miller Company.—This company has been organized to manufacture and contract for complete power plants, automatic locomotive boiler washing equipment, for washing and filling locomotive boilers with water heated by waste heat; for vacuum heating systems for roundhouses, shops and terminal buildings and for boilers, engines, pumps, heaters and piping. Mr. W. L. Miller, the president, was formerly connected with the Erie Heating Company, but has severed this connection to form the company which bears his name. The offices are Clark and Monroe streets, Fort Dearborn Building, Chicago.

New Watson-Stillman Plant.—The Watson-Stillman Company have moved into their new works at Aldene, N. J., where excellent shipping facilities are available on the Lehigh Valley Railroad. The plant includes a 100 by 182 ft. machine shop, of two stories, and a 120 by 35 ft. annex, a 62 by 100 ft. store house, a 60 by 74 ft. pattern shop, a 50 by 30 ft. blacksmith shop and powerhouse with electric distribution. This plant adds greatly to the manufacturing facilities of the company, all of the equipment being of the best, and it also provides admirably for manufacturing and finished stores.

J. G. Brill Company.—This company has lately received the following orders for its patented "Eureka" maximum traction trucks: 180 for the Tokio Electric Railway Company, Japan; 90 for the New South Wales Government tramways, Australia; 40 for the Tokio-Densha tramways, Japan; 42 for Marseilles, France, and 40 for Wigan, England. The "Eureka" truck was planned to meet all the difficult conditions found in cities, and is to-day more largely used than any other truck. The advantages claimed are that it carries long cars as low as does a single truck, and by bringing the load at certain points upon the side frames near the large yokes has the traction necessary to start quickly and climb heavy grades easily. The truck is standard in New York, Brooklyn, Baltimore, Boston, London, Liverpool, Paris, Sydney, Tokio and other large cities.

Federal Court Sustains Tesla Patents.—In pursuance of a decision handed down by him on February 20th, in the United States Circuit Court for the eastern district of Wisconsin, sustaining the contention of the Westinghouse Electric & Manufacturing Company that the synchronous motors of the National Electric Company were an infringement of the broad rights covered in Tesla patents Nos. 381968, 381969, 382280, 382281, Judge Seaman, in Milwaukee, on February 24th, enjoined the National Electric Company from the further sale of such motors. The decision in the suit is the first that has been obtained in the litigation begun some time ago by the Westinghouse Company to prevent the sale of synchronous motors and rotary converters by American manufacturers not enjoying a license under the Tesla polyphase motor patents. A decision is now pending in the United States Circuit Court for the southern district of Ohio in the suit brought by the Westinghouse Company against the Bullock Electric Manufacturing Company, alleging a similar infringement of the same patent rights in the sale of Bullock synchronous motors and rotary converters. The final hearing in the latter suit was conducted before Judge Thompson, in Cincinnati, on February 7th and 8th, Mr. Frederic H. Betts and Mr. Page appearing for the complainant. The Tesla patents involved in these suits have been the subject of considerable litigation in the past few years. The action instituted by the Westinghouse Company a number of years ago against the Thomson-Houston Company, for alleged infringement of the Tesla patents, was discontinued upon the execution of a patent agreement, under which the General Electric Company has for several years manufactured and sold induction and synchronous motors and rotary converters. A number of manufacturers have been enjoined from manufacturing induction motors, but the decision in the suit against the National Electric Company is the first court ruling that the synchronous motor is within the generic Tesla invention.

WANTED—Position as roundhouse foreman by man of executive ability and knowledge through experience. Has held such a position and present position of shop foreman for six years. Address M., care of Editor, American Engineer and Railroad Journal, 140 Nassau St., New York.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

APRIL, 1905.

CONTENTS.

* Illustrated Articles.

RECENT DEVELOPMENT OF THE FOUR-CYLINDER BALANCED LOCOMOTIVE.

With Comments on Superheating.

By A. von Borries.

Editor's Note.—Professor von Borries, from his intimate association with the modern development of German locomotive practice and his own important part in it, is qualified by wide experience to offer suggestions of the greatest value in the present stage of American practice.

The recent development of the locomotive has moved in two directions: The introduction of the four-cylinder balanced compound locomotives and the use of superheated steam. Many of the ideas contained in the present types are not new, but have been published a long time ago in patents and papers, been forgotten again, because the development of railroad service did not yet need them, or because science and practice were not then able to use them profitably in regular practice.

The four-cylinder balanced compound locomotive, which had its first development in France, then in Germany and Austria, is now regarded very favorably in the United States of America, so that there may be now running some 100 engines of this class, which number will increase at the end of this year to some 200. The good results, in consumption and steady running, which these engines showed on the testing plant at the St. Louis Exhibition in 1904 seem to have greatly extended this favorable opinion in the United States.

In America there are now two types of these engines, which resemble their European predecessors in the general arrangement: The Vauclain type, built by the Baldwin Works, where all four cylinders are arranged in one line under the front end, and all four pistons work on the front driving axle, as in the author's system, now generally used in Germany and Austria, and the Cole type, introduced by the American Locomotive Company, where the inside pistons work on the first, the outside ones on the second driving axle, as in the De Glehn system, generally used in France. The Vauclain system is illustrated in the American Engineer in December, 1904, page 466, the Cole in May, page 166, and the De Glehn in June, page 203. [The Vauclain arrangement is now built as mentioned above, and also divided, as are the De Glehn and Cole arrangements.—Editor.]

In the valve gear there is a difference, which is independent from the general arrangement of the engines. The Vauclain engines have one, the Cole engines two piston valves for both cylinders of each side, driven by one valve stem, and accordingly giving equal cut-off in the h.p. and l.p. cylinders. In this respect European constructors generally prefer to give the l.p. cylinders longer cut-offs than the h.p. ones, which requires independent motion of separate valves. In the De Glehn engines the cut-off in the h.p. and l.p. cylinders is kept fully independent from each other, so that four link motions are needed. In the author's valve gear a fixed proportion between the two cut-offs is attained with only two link motions of the Heusinger-Walschaert type by proper dimensions of the main levers.

The first advantage of the four-cylinder engines over those of two cylinders is the perfect balancing of the accelerating and retarding forces of the reciprocating parts by their opposite or opposed motion on each side, without balance weights in the wheels. Such balance weights are only put in for the equalization of the revolving parts, so that no centrifugal forces disturb the equal pressure of the wheels on the rails. This advantage applies to both systems of motion equally. By the self-balancing of the reciprocating parts the jerky motion (in longitudinal direction) is suppressed totally, if the h.p. and l.p. pistons have equal weights, otherwise it is reduced to a minimum. The turning motion around the center of gravity is reduced theoretically to about one-half, but experience shows that in practice it is negligible, being overcome by the different resistances against side motions on both ends of the engine.

With the balancing of the piston or steam forces in the running gear, there is a difference between the systems. In the De Glehn and Cole arrangements the outside pair of pistons work on the second driving axle just in the same manner as in an ordinary outside two-cylinder engine. Now, experience shows that the piston forces cause a wear of the brasses in the axle-boxes in longitudinal direction, so that the journals are drawn fore and aft in the boxes, causing the well-known blows, and this causes flat spots on the left side drivers, on a place which touches the rails, when the crank has passed its front center. This flat spot seems to be caused by a short sliding of the wheels in that position. It is always on the side of the following crank. English engines, which have generally the right crank following, show it on the right drivers. The whole matter has been thoroughly examined by Mr. Busse, chief mechanical engineer of the Danish State Railways.

Now, these blows and those caused by the flat spots are the usual reasons for taking the engines into the shops for fitting up the journal brasses and turning the tires, which must be done deep enough on all drivers to cut away the flat spot on that one wheel. The only way to delay as long as possible this objectionable wear is to fit the brasses as tight as possible nearly half around the journals, but the blows come again after a longer run. Now, when an engine goes in the shops, everything is overhauled and made ready for the next running, so that the cost of repairs depend to a great extent, not upon the miles run, but upon the number of repairs. The en-

gine which keeps running for the largest number of miles will, therefore, generally be the cheapest in maintenance, even if it is more complicated.

In the De Glehn and Cole systems the second driving axle is exposed to similar but smaller piston forces. Therefore, these engines may show the same special wear after a longer run. I have not had sufficient experience in this system, but I want to direct the attention of those who have such engines under control to this point. For the first driving wheels there is no fear in this respect, because two-cylinder inside engines show this wear, according to Mr. Busse's experience, in a very reduced degree.

In the Von Borries-Vauclain system, where all pistons work on the front driving axle, the piston forces on each side balance themselves to a great extent. The journals get no horizontal wear in their brasses, and the engines run free from blows and irregular wear of tires until they must go to the shops for general wear. Experience on the Hannover division of the Prussian State Railroads has shown that 25 two-cylinder 4—4—0 compounds, engaged in heavy express service, have run as an average some 41,000 miles from one turning of the drivers to the next, whereas 9 four-cylinder engines of the 4—4—0 and 4—4—2 types reached 67,000 miles as an average, some of them more than 90,000 miles. These figures prove the economy of these four-cylinder engines in maintenance. It would be very interesting if American railroads would fix similar figures for both types of engines, and try their running after averaging 40,000 to 60,000 miles.

Another advantage of the four-cylinder engines against the two-cylinder ones is the practically unlimited diameter of the cylinders, so that they may be dimensioned so as to do their heaviest work with economical expansion. Also the draft on the fire is more uniform from the four jets per revolution, instead of two, and by the reduced exhaust pressure of the steam caused by the greater expansion. For these reasons, the four-cylinder engines steam better at slow and medium speeds, that is, they take the inclines at higher speeds.

As to the valve gear, extensive trials have been made by German and French railways to find the best proportions of cut-off in the h.p. and l.p. cylinders, also on two-cylinder compounds. Of course, this proportion depends much upon the dimensions of the gear, especially the clearance space in the h.p. cylinders and the inside clearance of the h.p. valves. Generally, it has been found that a cut-off of 15 to 20 per cent. longer in the l.p. cylinders than in h.p., or a fixed cut-off of 60 to 70 per cent. in the l.p. gives the greatest economy in steam consumption. But it must be stated that nearly all the engines have too small ports in the l.p. cylinders, their section being only 1-14 or 1-16 of the piston area. This fault is also the real reason why compounds in so many cases would not do for high speeds. The Prussian 4—4—0 express engine introduced by the author in 1891 was one of the first with ports of sufficient section, and has done very good work at high speeds. With small ports the cut-off in the l.p. cylinder had to be enlarged with increasing speed, for the purpose of giving the steam larger passages. Recent experiments with four-cylinder engines, where the l.p. cylinders have ports of 1-10 to 1-8 of the piston area, show that the cut-off may be reduced.

The real reason why the l.p. cylinder should have a longer cut-off than the h.p. is to keep the intermediate pressure low enough to prevent too high compression in the h.p. cylinders, with reasonable clearance spaces and inside cuts in valves. Of course, it is possible to run an engine with a proportion of piston areas of 1 to 2.8 with equal cut-off of 30 per cent. in both cylinders, but then the h.p. cylinder must have a clearance of 22 per cent. and large inside clearance in the valve, so that the engine will work less economically when run with longer cut-offs. The degree of expansion at 30 per cent. is

$$\frac{0.3 + 0.22}{2.8} = \frac{1}{5.4}.$$

With a piston proportion of 1 to 2.5 a clearance of 12 per cent. in the h.p. cylinder is sufficient when the cut-off in the l.p. cylinder is 15 to 20 per cent. greater than in the h.p. one. The total degree of expansion at 0.3 is

$$\frac{0.3 + 0.12}{2.5} = \frac{1}{6}.$$

This engine will work more economically at longer cut-offs, because the intermediate pressure thus rises, and the compression fills up the h.p. clearance space better, correcting the shorter compression. Therefore, the differential cut-off enables the engine to work more economically with different tractive force. As in the four-cylinder engine itself, in comparison with the two-cylinder, economy stands against simplicity, but I believe the economy will prove preferable.

The well-known fault of the two-cylinder compounds, that the great degree of total expansion causes much condensation in the l.p. cylinders, is felt still more on the four-cylinder engines, because they work with still larger expansion. This condensation, of course, reduces the economy. Examinations of indicator cards seem to show that there is very small condensation in the h.p. cylinders. Therefore, it would, perhaps, be a good plan to superheat the steam on its way from the h.p. to the l.p. cylinders, which might be done by a simple superheater in the smokebox. The difficulties of the high pressure and high-superheated steam would be avoided by this method. Of course, the l.p. cylinders would have to be larger in proportion to the larger volume of the superheated steam.

This leads me to the superheater engines, of which the first was built in Germany in 1898, according to plans prepared by Mr. W. Schmidt, of Wilhelmshohe. (This superheater was shown in the AMERICAN ENGINEER, November, 1902, page 340.) Mr. Schmidt's intention was to superheat the steam to such an extent that condensation in the cylinders would be avoided. For this purpose the steam of 176 lbs. pressure and 374 deg. of heat must be superheated to about 572 deg. Theoretically, superheating to this extent should give an economy of fuel of some 25 per cent., and of water of some 30 per cent., compared with simple engines for the same total work. As soon as the speed is higher than that which corresponds to the limit of adhesion, because of the increased capacity obtained per unit weight of the engine, superheating becomes still more effective. An ordinary express engine consumes one-half of its tractive force for its own motion; a superheater engine of same weight, which produces 30 per cent. more total tractive force, would draw a train of 60 per cent. heavier weight at the same speed.

These favorable figures seem to be not quite fulfilled now. But it has been stated that a superheater engine of the 4—4—0 type weighing some 54 tons does the same work in express service which requires a 4—4—2 compound of 62 tons. The work done by the superheater engines or, properly said, by the superheated steam, is excellent, the gain increasing with the speed. The small consumption of water is specially favorable for long runs. On the other hand, the superheater engines are still more liable to defects, and they are, therefore, oftener and altogether longer in the shops than other engines. This is caused partially by the heavier wear of driving boxes and tires, partially by occasional defects of the special parts connected with the superheating.

The simplest type of locomotive superheater is the Pielock, in which the central portion of the boiler flues is inclosed by a case, and thereby separated from the boiler, the water being kept out by the case. The steam from the throttle passes through this case and among the tubes on its way to the cylinders. This superheater is regarded favorably here in Germany, because of its simplicity, and because it gives no trouble in service. In some cases the tubes have become corroded outside, but this is the only point requiring attention. In all other respects boilers fitted with these superheaters are worked like others. A special feature of the Pielock superheater is that it may be applied to old boilers.

The horizontal wear of the driving brasses and the resulting blows and irregular wear of tires, as previously described, is greater than on other simple engines, because the superheaters have larger pistons, on account of the larger volume of

the steam, and, therefore, the piston forces are greater. Compared with compounds, the difference is still greater. I have no figures, like those mentioned before, when comparing the two and four-cylinder compounds, but it is important to state in practice the wear of tires for 100,000 miles running with the different types of engines. Of course, this figure and the smooth running would be nearly as good as with the four-cylinder balanced compounds, if the superheater engine is also built with four cylinders in the same manner. But then the question arises, whether it will not be better to retain the compound system with superheated steam. The question can only be settled by experience. On the Canadian Pacific Railroad the superheater compounds seem to have been more economical than similar simple engines, but the results seem not sufficient to settle the question. The four-cylinder simple engine would, of course, be simpler, but the compound would probably be more economical, owing to the larger degree of expansion and the larger opening of the ports by the valves.

Regarding the occasional defects, or "locomotive failures," what Mr. Basford reports from the English railways, that engine failures on trains are very unusual, also applies to German railways. Now, it is well known how successfully Mr. Schmidt and Mr. Garbe have overcome the great difficulties which stand against the use of steam of such high temperatures; but there are some features in this system which occasionally give trouble. What I have to say about this may, perhaps, be useful for our American colleagues, to enable them to avoid the same difficulties.

The large flue tube which conducts a part of the fire gases to the Schmidt smokebox superheater is liable to leak at its connection with the firebox tube plate, if this connection is not made with the greatest care. The flues of that superheater sometimes break near the tube plates of the steam boxes, in which they are fastened, probably by strain from expansion, by heat or vibration. Such a breakage makes the engine unfit to continue its run, because the tube ends cannot be filled up by plugs like a broken flue. The inside walls, which separate the superheater from the inner space of the smokebox are exposed to high heat and burnt or bent, even if made of cast steel, instead of sheet iron. For these reasons I prefer the newest style of superheaters of the Schmidt and the Cole types, where the superheater tubes are put into a number of enlarged flues in the upper part of the boiler. These flues will not be more liable to trouble than the others, because they are secured in the same manner, and the superheater tubes are free to expand and well supported. This style of superheaters also give the least weight. The Schmidt fire tube superheater, as applied to a Canadian Pacific locomotive, was illustrated in the American Engineer in September, 1903, page 317, and the Cole superheater in September, 1904, page 338, and December of that year, page 456.

In the main steam tubes which conduct the steam to the cylinders all brass or copper parts must be avoided, because these materials do not stand the heat. Also I would prefer to conduct the side steam tubes immediately to the valve chests in the usual American manner through ports in the saddles, because the saddles would be heated locally too much, causing excessive inner strains, which might cause breakages. Also there would be a great loss of heat in the great mass of the saddle. For the same reasons the walls of the valve chest, where they are exposed to the superheated steam, should be insulated or independent from the other parts of the cylinder casting, especially from the cylinder walls themselves, where the heat would cause friction of the pistons. The steam pipes and valve chests must be large enough to act as a reservoir for the cylinders, together with the superheater.

The small piston valves employed by Mr. Schmidt of only 6 ins. diameter, with double ports for admission, are very light, durable and simple, but they have no packing rings, and a considerable part of the steam passes around them into the exhaust. It is difficult to fit them in the proper manner, so as to avoid friction on the one hand and excessive leakage on the other. Friction has in some cases caused breakage of valve stems. The first superheater engines had larger pistons with packing rings, which worked quite well and were tighter. Also in this question experience must show what sort of valve will be the preferable one.

Superheated steam is lighter than saturated, and, therefore, passes the ports and passages with less resistance. Therefore, the ports can be kept smaller in section, and the lead of the valves should be smaller than usual, especially with double-ported valves, to secure easy working of the engine. For large lead causes much friction, hot crank pins and loose cylinders. The economy of locomotives depends much upon the proper lead.

I hope that the foregoing remarks will be of some utility to our American colleagues in directing their attention to some points, which seem essential in the present development of the locomotive.

LOCOMOTIVE TESTS AT THE ST. LOUIS EXPOSITION.

THE CLASS H 6 A, 2—8—0 LOCOMOTIVE.

No. 1,499 of the Pennsylvania Railroad, tested at St. Louis last year on the testing plant, illustrated in this journal last month, was the first locomotive ever to undergo such a remarkably thorough series of tests. Bulletin No. 4, published by the Pennsylvania Railroad System, records this series of tests in full, and is a valuable document. It records seventeen tests made from June 11th to June 27th of last year. No test was shorter than 130 minutes, and the longest was 210 minutes. Until the complete record of the tests made on all the locomotives are available, as they will be later in book form, no comparisons can be drawn, and to properly represent the performances of the first locomotive the entire bulletin should be reproduced. An idea of the performance, however, may be given by stating the ranges of the data.

The lowest average boiler pressure was 176.9 lbs., while the highest was 203.4 lbs.; in general, the variation of average pressure did not exceed 5 per cent. The quality of steam, as measured by a throttling calorimeter, was uniformly high, the moisture never exceeding 1¼ per cent. The equivalent lbs. of water evaporated per sq. ft. of grate surface per hour ranged from 262 to 625. The equivalent evaporation per sq. ft. of heating surface ranged from 5.18 to 12.39 lbs. per hour. The maximum boiler horse power, based on 34.5 units, was 891.3; the horse power per sq. ft. of heating surface ranged from 0.15 to 0.359. The dry coal per sq. ft. of grate area per hour ranged from 22.7 to 86.4 lbs. The coal burned per sq. ft. of heating surface per hour ranged from 0.450 to 1.713 lbs. Firebox temperatures ranged from 1,427 to 2,112 deg. Fahr., and the smokebox temperatures from 561 to 726 deg. Fahr.

The equivalent evaporation per lb. of dry coal ranged from 11.53 to 6.63 lbs. The efficiency of the boiler dropped rapidly as the rate of evaporation increased, the range being between 78.93 per cent. and 45.37 per cent. In the smokebox gases the carbon dioxide ranged from 9.75 to 13.03 per cent. The lowest speed at which any test was run was 6.67 miles per hour, and the highest speed 26.68 miles. The highest indicated horse power was 1,036, obtained at 35 per cent. cutoff, at a speed of 120 r.p.m. The best performances of the engine was at 31 1-3 per cent. cutoff and 120.12 r.p.m. (about 20 miles per hour), and under which condition the steam consumption was 23.43 lbs. per indicated horse power per hour. The maximum average recorded drawbar pull was 2,278 lbs. at 80 r.p.m. and 37 per cent. cutoff. Higher drawbar pulls were not obtained because of the danger of stalling the brakes at low speeds and long cutoffs. A maximum dynamometer horse power of 848.6 was obtained at 120 r.p.m. and 35 per cent. cutoff. The general tendency was to increase the coal per dynamometer horse power as the speed increases, the minimum coal rate being 3.54 lbs. and the maximum rate 6.48 lbs. The lowest steam consumption was 26.14 lbs. per dynamometer horse power hour, obtained at 80 r.p.m. and 37 per

cent. cutoff. The average value of frictional horse power for speeds of 40, 80, 120 and 160 r.p.m. was 83.1, 132.5, 187.2 and 224.2, respectively. The machine efficiency ranged from 72.89 to 84.82 per cent. The maximum evaporative power of the boiler was between 25,000 and 26,000 lbs. of dry steam per hour, which is equivalent to a rate of evaporation of between 10 and 11 lbs. per sq. ft. of heating surface per hour.

The record of the tests is given in admirably complete form, by aid of tables and diagrams; the pamphlet also includes a detailed record of the data, drawings illustrating the engine, indicator cards and summaries of results. Those interested in the development of the American locomotive should procure copies of this record, as it is impossible to properly present the results in an abstract.

This locomotive was one of eight tested at the exposition, and the final results, affording an opportunity for comparisons, will be awaited with the greatest interest.

STEEL CAR DEVELOPMENT.

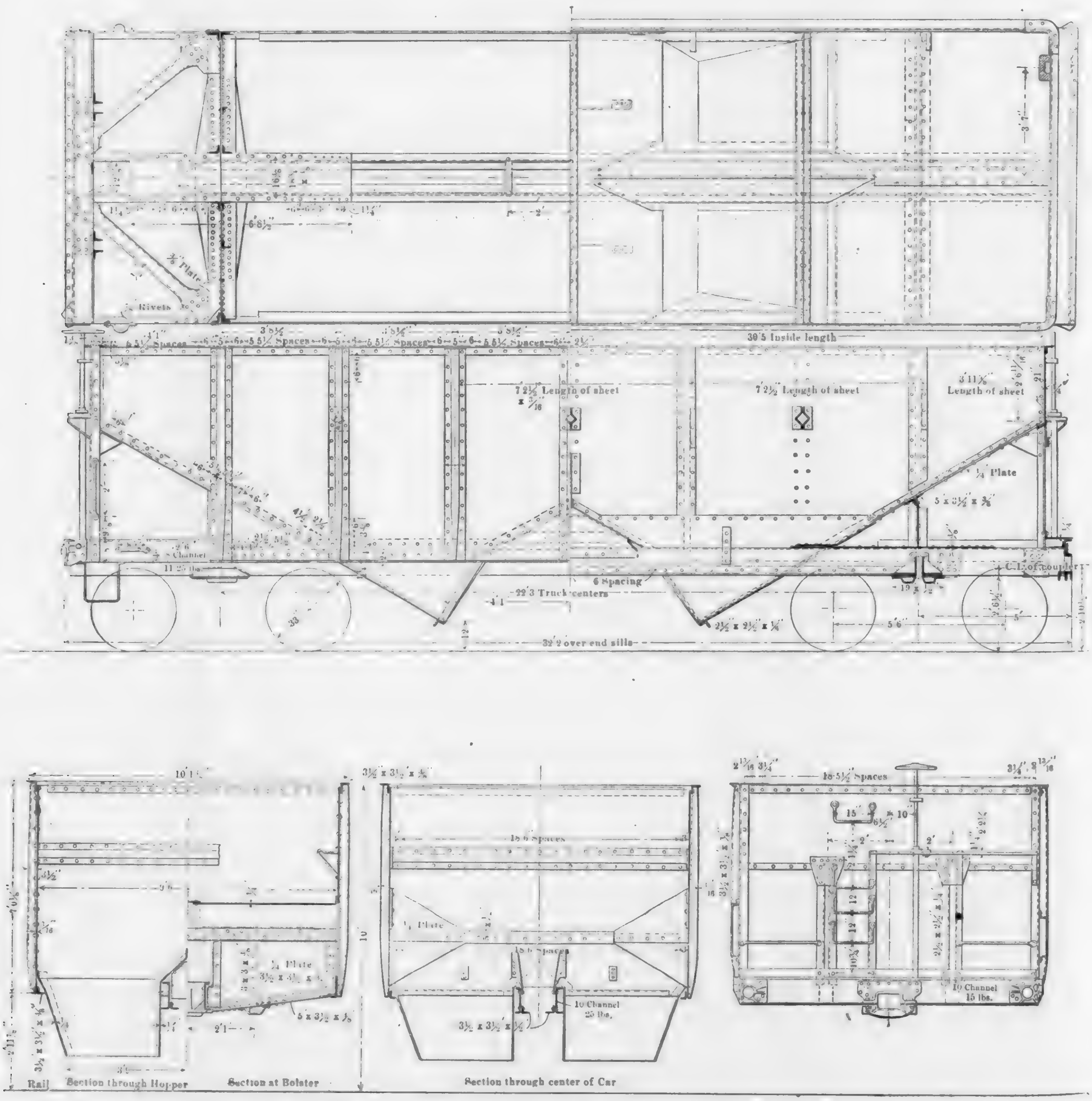
PENNSYLVANIA RAILROAD.

VI.

(For previous article see June, 1904, page 209.)

This series of descriptions of Pennsylvania Railroad steel cars has been interrupted, and will now be brought down to date. Previous articles will be found in the volume of 1903 pages 352, 402, 435, and in 1904, on pages 3 and 209.

The latest design is Class GLA, which is a development of the GL class, described on page 435 in December, 1903. The latter design has remained until recently the single standard coal car of this road. The type was brought out in pressed steel on the Bessemer & Lake Erie Railroad, and its adoption

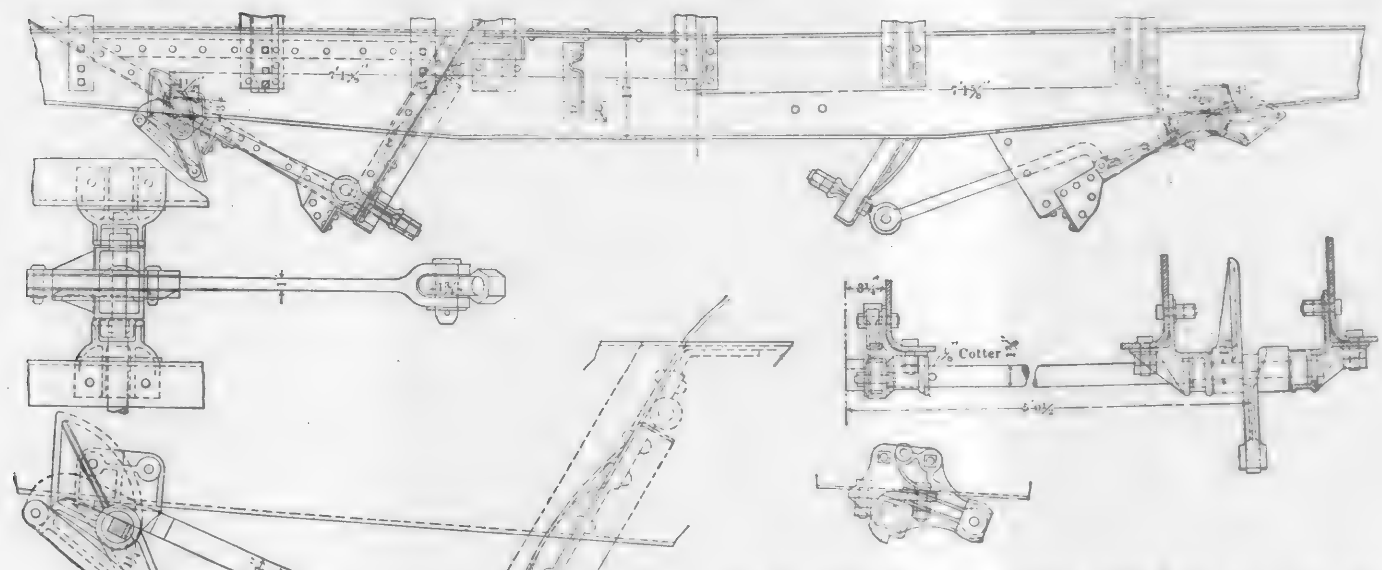


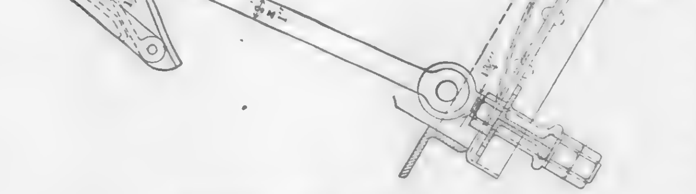
100,000 STEEL HOPPER CAR, CLASS GLA, PENNSYLVANIA RAILROAD.

y the Pennsylvania settled the form and type of the largest number of steel cars built in this country. The type resulted from the Class GG, wooden car. The design of the GL was simultaneous with the GM car, shown in November, 1903, page 402. The weight of the GL is 39,150 lbs.; the cubical capacity, 1,897 cu. ft., and its ratio of paying to dead load, 36.4 per cent. For the construction the description of this car may be consulted.

The GLA car is mainly a structural instead of a pressed steel car, and it has straight (instead of "fish-bellied") longitudinal sills, of 10-in. channels, reinforced at the lower flanges with 3½ by 3½ by ½-in. angles, as shown in the sectional views. It has no side sills between the bolsters, the short 8-in. channels reach only from the end sills to the bolsters. This is the first hopper coal car of 50 tons' capacity on this road, built in large numbers, utilizing the side plates in carrying the load. The GM hopper car (November, 1903, page 402), however, was constructed in this way, and established this principle in 1896.

The GLA design is similar to the GL in size and general features. It has the following dimensions:





SIMONTON DOOR OPERATING GEAR.

CLASS GLA HOPPER COAL CAR.

Total length over end sills	32 ft. 2 ins.
Length inside	30 ft. 5 ins.
Length between truck centers	22 ft. 3 ins.
Total height above rail	10 ft. 0 ins.
Total width	10 ft. 1⅜ ins.
Width inside	9 ft. 6 ins.
Weight	38,600 lbs.
Cubical capacity, level full	1,683.4 cu. ft.
Cubical capacity, heaped	1,900 cu. ft.
Ratio dead to paying load	35.1 per cent.

The weight is 550 lbs. less than that of its predecessor. For the first time on the Pennsylvania a single plate body bolster is employed in this type of car. It is secured to the inclined floor between two 5 by 3½ by ⅜-in. angles. To provide for end shocks the center sills have a cover plate 6 ft. 8½ ins. long, extending from the hood of the hopper to a point more than half-way from the bolsters to the end sills. The diagonal bracing of the ends of the frame is shown clearly in the plan view. In the center of the car diagonal plates stiffen the construction, as indicated in the side elevation. Instead of ¼-in. side plates on the preceding design, the GLA has plates only 3/16-in. thick, which still further lightens the construction.

These cars are equipped with the Simonton door operating gear, which is illustrated because it is an inexpensive gear, which has proved entirely satisfactory in service. A large number of these have been in use for several years without one having opened accidentally. This gear is operated by a squared shaft extending across the car. The door links terminate at their upper ends in the form of hooks. These hooks, when in the closed position, are drawn down over the shaft castings, locking the doors securely.

The GLA car is presented out of its order in this series, because it is the latest design of the Pennsylvania Railroad.

CAPACITY IN LOCOMOTIVES.

Seldom has a subject connected with locomotive practice been acorded the genial reception which is given quite generally to that of superheating. Thus far only two roads on this continent pretend to know superheating from experience, but everybody having to do with locomotives is ready to talk about it, and those who have no superheaters appear to know most about the principle. Was there ever before an improvement of the locomotive which impressed people as this has? There must be something in it. There is something in it, and more than that, opinions with respect to locomotive practice in this country are changing very rapidly. People are now ready to apply to the locomotive the principles which have brought marine and stationary engines to their present development. Why is this. Is it because of a desire to advance economy or efficiency for its own sake? It is because up to this time the locomotive has grown mainly by increasing size in order to increase capacity. Details of small engines which give no trouble are exceedingly troublesome when made bigger for the powerful engines of to-day. Weights have increased to the point of jeopardizing cool running even with the very best designs. Merely increasing size is unwise, unscientific and wrong. The time has come for making the most out of the weights which must be used and improvements, such as superheating, are accepted and gladly accepted because they offer means for increasing capacity.

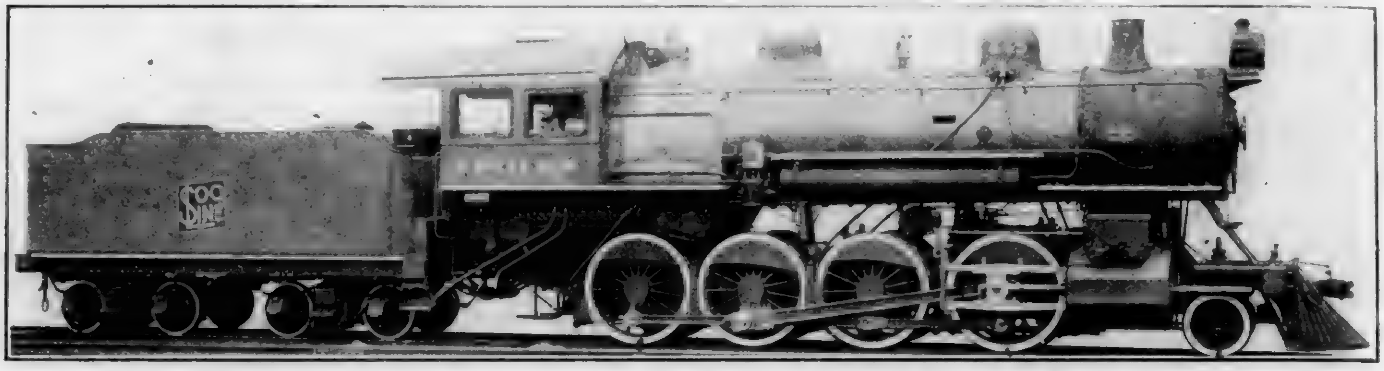
Compounding has never been appreciated by locomotive men until now, when it is clearly understood to be a source of increased capacity. Improved valve gears have had the "cold shoulder" for many years, but nowadays people are talking about them and they frequently ask which of several recently developed is the best and most likely to justify trial. Ten years ago a man with an automatic stoker would have been politely (perhaps) bowed out of the office. Now many are looking eagerly for the man who has a feasible plan to suggest for mechanical stoking.

All this has come rather suddenly. It all points in one direction—toward the greatest period of development of the locomotive and it justifies great hopes for the immediate future.

COMPOUND SUPERHEATER FREIGHT LOCOMOTIVE.

2—8—0 Type "Soo Line" Railway.

Two-cylinder compound locomotives of the 2—8—0 type having Cole superheaters have been put into service by the Minneapolis, St. Paul & Sault St. Marie Railway, which are generally similar to but are heavier and more powerful than others of the 2—8—0 type used on this road. The new ones have 37,300 lbs., as compared with 37,000 lbs. tractive effort of the previous class. These engines were built at Schenectady. The Cole superheater provides 261.4 sq. ft. of heating surface, which is slightly less than 10 per cent. of the total heating surface. The superheater is provided for in 40 tubes 3½ ins. in diameter. While the arrangement of the superheater is that used previously by Mr. Cole, the superheater tubes have been changed somewhat from previous construction. The combination of two-cylinder compounding and superheating will be watched with interest, as it is an open question whether compounding is necessary with superheated steam. This road has a number of 2—8—0 type 2-cylinder compounds which are giving very satisfactory service, and the opportunity for comparison is an excellent one. The Canadian Pacific two-cylinder compound with superheater was illustrated in this journal in September, 1903, page 317, and the performance was recorded in December, 1904, page 457.



COMPOUND LOCOMOTIVE WITH SUPERHEATERS.—"SOO" LINE RAILWAY.

T. A. Foque, *Mechanical Superintendent.* American Locomotive Company, *Builders.*

These locomotives were designed under the direction of Mr. T. A. Foque, mechanical superintendent of the road. The chief dimensions are given in the following table:

COMPOUND SUPERHEATER FREIGHT LOCOMOTIVE—"SOO LINE."

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	37,300 lbs.
Weight in working order	201,500 lbs.
Weight on drivers	172,000 lbs.
Weight on leading truck	29,500 lbs.
Weight of engine and tender in working order	318,400 lbs.
Wheel base, driving	17 ft.
Wheel base, total	25 ft. 11 ins.
Wheel base, engine and tender	55 ft. 10½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.61
Tractive effort x diam. drivers ÷ heating surface	916
Heating surface ÷ grate area	54.8
Total weight ÷ tractive effort	54.0
CYLINDERS.	
Kind	Compound.
Diameter and stroke	23 and 35 by 34 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	Piston and slide.
Greatest travel	6 ins.
Outside lap	H.P., 1¼ ins.; L.P., 1 in.
Inside clearance	¼ in.
Lead in full gear	Line and line.
WHEELS.	
Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 10 ins.
BOILER.	
Style	Extended wagon top.
Working pressure	210 lbs.
Outside diameter of first ring	67⅝ ins.
Firebox, length and width	98 by 70 ins
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 and 4½ ins.
Tubes, number and outside diameter	224 2-in.; 40 3½-in.
Tubes, gauge and length	11 and 8, 15 ft. 9 ins. long.
Heating surface, tubes	2,407.5 sq. ft.
Heating surface, firebox	158 sq. ft
Heating surface, total	2,565.5 sq. ft.
Superheater heating surface	266 sq. ft.
Grate area	46.8 sq. ft.
Exhaust pipe	Single.
Smokestack, diameter	16 and 18 ins.
Smokestack, height above rail	14 ft. 9 3-16 ins.
Centre of boiler above rail	115 ins.
TENDER.	
Tank	U-shaped.
Frame	10-in. channels.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	6,000 gals.
Coal capacity	10 tons.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

Berlin.

Continental locomotive designers have not hesitated to complicate their locomotives when any gain in economical operation was possible. They have used four cylinders and improved valve gears, and have many balanced locomotives. This is important to us, for we must follow in the use of four-cylinder balanced engines and in improved valve gears, but for reasons differing widely from those which inspired the French and Germans. Over here economy of operation is the main object, and balancing and lightening the parts seems less important. We need the four-cylinder balanced engines in order to increase wheel loads and to lighten the parts. We need the Walschaert valve gear because there is not room enough for eccentrics, because our eccentrics are so large as to involve excessive surface velocities, and because the Walschaert gear is lighter. It is interesting that we should be driven in the same directions for such different reasons. Incidentally, however, we shall also gain in the matter of operating economy, which is so much the better.

At this point a brief comparison between English, French and German locomotive practice seems appropriate. In England competition has had a very important effect, and the English railways serve the convenience of the people better than those of any other country which I visited. There are trains for all kinds of people; workmen travel to and from their homes to the large cities for almost nothing, and the best accommodations are available for those who can pay for them. English train service is exceedingly good, and the efficiency of the English railway "servant" is a source of

wonder. The amount of work done by a few poorly paid employes is remarkable. The competition has led to the perfection of locomotive design for conditions which are, however, rapidly changing as the weights of trains increase.

France went at the locomotive problem scientifically. With comparatively little competition, locomotive practice has been carefully and thoroughly developed, and the roads not having competition have profited by those which have it. The lines to the north and east, where competition exists, have the best equipment, and no locomotive practice better fitted to any given conditions is to be found anywhere.

Germany has settled down in general practice to a rather uniform lot of excellent locomotives, beautifully designed and built, but they do not make good when trains are late. Germany needs to provide heavy locomotives, with a greater amount of sustained capacity, as, like all other countries, her trains are becoming heavy.

Shop labor in Germany is cheap, and trained designers are everywhere available. This explains the beauty of finish of German engines and the care in design, which, for example, renders a main rod of the Von Borries' engines a work of art. The rods and parts of valve gear are very light, yet they do not break. I could not secure satisfactory figures of locomotive failures in Germany, but am confident that they are as infrequent in Germany as in England. Undoubtedly this is because the locomotives are not worked to death.

While I had a glimpse of Swiss and Italian practice, I did not make a study of the conditions of those two countries, and greatly regret that I could not go to Austria to study the work of Herr Golsdorf.

One's first railroad journey in Germany leaves an indelible impression of efficient station service. Instead of dallying at stations and working locomotives to the limit of their capacity to make up the time wasted, the Germans believe that the best way to make up time is when engines are standing still at stations. If the trains I used are fair samples, they surpass all others I ever rode in in this respect. The trains loaf along the road, but the station work is a fit subject for a cinematograph record. This comes from the station organization and from the military experience of every able-bodied German. When a train stops it passes out of the control of the conductor and locomotive engineer, and the station master becomes supreme. He has the baggage trucks "spotted" for the cars, and his men are all out and wideawake. There seems to be no lack of men, and they are thoroughly trained to work quickly. When everything is ready the station master blows a small brass horn, which would delight the heart of a five-year-old boy, but it starts the train and ends his responsibilities, which evidently have weighed upon him. Two minutes per stop was the time for many stations. This was not confined to long-distance trains. I found quick station service to be the rule in Germany, and it was pleasing as well as unexpected. Our general managers would do well to try the possibilities of this sort of thing at home. It would help the locomotives, the firemen, the coal pile, and, in fact, everything and everybody concerned in train service.

In Germany among many locomotive designers Professor A. von Borries is a central figure. He is professor of the Technical High School at Berlin, and is also state counsellor in locomotive matters, and has for years been closely identified with the locomotive equipment in Germany. The equipment for which he stands as sponsor is important to Americans just now. His article in this issue of the AMERICAN ENGINEER is timely, because it treats of the four-cylinder balanced compound and superheating.

Professor von Borries uses four cylinders, compounded and in a balanced arrangement, but instead of dividing their efforts between two axles, all four cylinders connect to the one axle, which is cranked. This differs materially from the de Glehn system, and as von Borries' ideas have been embodied extensively into German practice, they are worthy of most careful attention.

The von Borries construction brings the cylinders together. The two valve motions for high and low pressure cylinders are handled as one valve gear from the cab. Professor von Borries claims that connecting all the cylinders to one axle subjects that axle to very little more stress than that of de Glehn's arrangement. The cranked portions receive stresses from the inside cylinders, and those from the outside cylinders are largely transferred through the coupling rods. Von Borries makes a strong point of balancing the forces of the pistons and reciprocating parts on one axle because of its effect upon the wearing and knocking of the driving boxes, due to horizontal lost motion from wear of the brasses. He supports this view by comparisons of mileage between shoppings of engines on his system and de Glehn's, arguing that the freedom from wear of the driving boxes affected the tire wear favorably, and thus greatly increased the period between shoppings and consequently the cost of repairs. Professor von Borries says that his engines do not develop knocking in the boxes in mileages as high as 45,000. I did not ride on one of these engines, but am informed that they run very smoothly, thus confirming the claim referred to.

Professor von Borries is a painstaking student of valve motion and steam distribution, and is not one to turn aside from complication if he thought he could gain by it. He prefers to fix the proportions of expansion by connecting the reversing motions of both high and low pressure cylinders to the same reversing gear than to use the separate adjustment method of the de Glehn system. In support of this he cites performance records to show that the engineers in Germany do not use the separate valve gear to the best advantage. He may be entirely right in this, but my observations on the de Glehn compounds on the Northern Railway of France lead me to believe that the best locomotive arrangement is not too good, and that the men should be educated up to the best. I do not believe American locomotive engineers are up to handling either the von Borries or the de Glehn systems, but so much the worst for our railroads. The best system should be used, and the men should be educated up to it. I believe the von Borries engines, if the men were perfect, would be more efficient with separate control of the valve gears.

In France piston valves do not seem to be in high favor, and Mr. de Glehn heartily disapproves of them. Herr von Borries disagrees with him, and prefers piston to slide valves for high pressure cylinders. He uses piston valves for high pressure and slide valves for low pressure cylinders, driving both by the same valve motion on each side of the engine.

The von Borries, like the French and English locomotives, are beautifully designed. The careful work of the drawing room is shown, especially in such details as the valve gear, main and side rods. These appear absurdly light, compared with ours, but they never break. What they would do on our roads, where 4-in. shims are required under the rails in winter, is another question. They are unquestionably well adapted to the conditions under which they work.

My impression is that the Germans have sought accessibility to a greater extent than the French. They do not hesitate to complicate construction where it is desirable. They, however, do not willingly admit that they can learn much from France, and in this they are not alone. They can certainly learn much (and so can every other country I visited) from France in the handling of fast passenger locomotives. The prejudices of patriotism should break down before a matter of so great import as the study of transportation methods.

G. M. B.

(To be continued.)

WEIGHT OF A CROWD OF PEOPLE.—Authorities and building laws differ as to the weight per square foot to be allowed for a crowd of people. Some have put it as low as 40 lbs. and others as high as 150 lbs. In order to satisfy himself of the possible weight for floors and bridges, Mr. Lewis J. Johnson recently made some experiments, and described them in the *Journal* of the Association of Engineering Societies in January, 1905. His greatest load was 181.3 lbs. per ft., and was obtained by packing 40 men, averaging 163.2 lbs. each, into a space 6 ft. square.

SIDE DOOR SUBURBAN PASSENGER CARS.

ILLINOIS CENTRAL RAILROAD.

Sixteen of the Sullivan-Renshaw cars illustrated in this journal on pages 204, 327 and 358 of the volume for 1903 are now in the suburban service on this road, where they have displaced 32 wooden cars of the type heretofore exclusively used. The cost of repairs of the new cars has been very low; they have furnished absolute protection from personal injury of passengers and the stops are marvelously short. These facts and other information concerning these cars are contained in a communication from Mr. A. W. Sullivan, now general manager of the Missouri Pacific Railway, who, when with the Illinois Central, designed these cars with Mr. W. Renshaw, superintendent of motive power of that road.

In the cars last built and put in service last fall, the details of the appointments have been perfected, so that they are now complete in every particular, and are working with great smoothness and efficiency.

In a recent stop watch test of the time required in making a local run with a 3-car train carrying 450 passengers, the following record was obtained; the time being taken from the moment the train came to a full stop until it started, during which interval, at each station, the side doors were unlocked, opened, the passengers discharged and admitted to the train, the doors closed and locked.

Stations.	Time of stop.	Stations.	Time of stop.
16th st.	7 sec.	47th st.	12 sec.
22d st.	5 sec.	50th st.	9 sec.
26th st.	6 sec.	53d st.	10 sec.
31st st.	8 sec.	57th st.	6 sec.
36th st.	12 sec.	60th st.	5 sec.
39th st.	7 sec.	63d st.	3 sec.
43d st.	9 sec.		

The average time of the 13 stops was 7.61 seconds. This test was made without the knowledge of the train crew, and there was therefore no different handling from that which ordinarily obtains in the service.

The cars have been in regular daily service now for a period of 19 months, including two of the most severe winters on record in Chicago. Notwithstanding the extreme cold weather and the severe storms to which the Illinois Central trains are exposed by reason of the location of the railroad for a distance of 7 miles along the shore of Lake Michigan, the cars have at all times been kept comfortably warm, with a much less consumption of steam than required in the end-door cars performing the same service.

The impossibility of any one getting on or off the cars, or in any manner attaching themselves to the train while in motion, has eliminated personal injuries as a factor of the service

The electric train signal, with which all the side door cars are equipped, has been in continuous use for over a year, and has worked most satisfactorily throughout the severe weather of the past winter. By the use of this signal the trainmen are relieved from giving the signal, by passing it from one to the other, from the rear of the train to the engine. This slow and cumbersome method, fraught with possibilities of mistakes, is entirely eliminated by the electric signal. It is operated automatically by the mere act of the trainman in opening and closing the side doors, and only when the last open door of the train is closed does the engineer get the signal to start, which can then be done instantly with the positive assurance that all the doors are closed and locked.

By this system the trainmen work independently of each other, opening and closing the doors of their cars to suit the requirements of the passengers without reference to what the other trainmen are doing. As the circuit by which the starting signal is controlled can be completed only by the closing of the doors, the last man to close the door practically starts the train. The operation of the signal is instantaneous and can be worked just as effectively on a train of 20 cars as on a train of 2 cars. This electric signal, which is an essential part of the side door scheme of operation, contributes greatly to the quickness and the safety of the results obtained.

The operation of the side door cars has passed the experimental stage, and may now be considered entirely practicable and highly efficient.

From Mr. Sullivan's report to the International Railway Congress on suburban service, the weight and carrying capacity of suburban cars on 23 American railroads are given, from which the following comparison is drawn:

	Number of seats.	Length over endsills of underframe in ft.	Total weight of cars.	Total weight. Per lineal ft.	Total weight. Per seat.
Illinois Central, new cars	100	64	84,600	1,323	846
Average of suburban equipment of 23 American railroads	64.61	52.9	60,925	1,144	942

DANGERS OF PRESENT PASSENGER CAR CONSTRUCTION.

Whether it will be generally admitted or not, the influence of the officials of the United States railway mail service toward improving the end construction of passenger cars is a powerful one, which should receive careful thought among railroad men. Another influence in the same direction is the policy of the Pullman Company in making its cars so strong and heavy that they are sure to survive wrecks in good condition. Postal cars and Pullman sleepers, when strengthened against collision damages, constitute a source of serious danger to other cars in the same train which are not specially reinforced. Recently a wreck in the New York Subway proved the superior strength of a steel car over a wooden one to have been gained at the expense of the wooden one.

It is well enough to argue that cars are supposed to run without accidents, but accidents certainly do occur, and the gradual increase in train speeds is likely to increase rather than decrease the number. Strengthening a few or all cars cannot prevent wrecks, and it is clear that strengthening a few cars increases the danger to passengers when wrecks do occur.

It is clear that all cars must be strengthened so that the force of a collision will not become dissipated by crushing or telescoping. There is nothing mysterious about this. Very simple and satisfactory designs are now in use, employing steel frames and end construction of ample strength. What is the trouble? This may be answered by asking a question. What real improvements have been introduced into the construction (taken as a whole) of ordinary passenger cars during the past twenty years?

The question of a properly designed steel underframe, with specially strong end construction, including friction draft gear, to assist in absorbing shocks, is squarely before the railroads. When some important road brings out a good steel frame passenger car, even if the entire car is not at first of steel, the other roads will tumble over each other to follow suit. It will be interesting to see who will "take the bull by the horns" and meet this emergency. If it is not done soon by the railroads themselves, legislation and perhaps an amplification of the safety appliance law may be expected as inevitable.

One reason for the lack of progress in passenger cars is that matters of design, and largely also of construction, have been allowed to remain in the hands of the builders, and we have commercial car builders' cars rather than railroad men's cars. But this is the fault of the railroads. It will not do to longer delay, or the public will be heard from in an unmistakable voice. Draftsmen should be set to work at once to build steel frame cars, if not all steel cars. They should begin with clean sheets of paper, and avoid spoiling steel construction by an attempt to bend or adapt it to the methods necessary with wood.

Another construction for American railroad officials to take up is an improvement in the prevailing type of six-wheel trucks, with their vast number of parts.

EPORT OF COMMITTEE ON FREIGHT EQUIPMENT.

ROCK ISLAND COMPANY.

EDITOR'S NOTE.—Simultaneously with the study of the condition of the locomotives of the Rock Island-Frisco System, which resulted in suggesting standard locomotives (AMERICAN ENGINEER March, 1905, page 84) by the power committee, a committee began an equally elaborate study of the condition of cars, and reported in favor of standards for future construction. This report contains much confidential information, but the portions which are of general interest are presented in abstract by permission of Mr. Robert Mather, chairman of the executive committee.

The committee was instructed,

First.—To make an investigation of the freight equipment of the Rock Island and Frisco systems, and present a detailed statement of the same, together with recommendations looking (a) To the increase in its capacity and usefulness. (b) To the prolongation of its life.

Second.—To prepare standard designs for all classes of cars.

On August 19th and 20th a preliminary meeting was held at the office of the chairman in St. Louis, at which were present Messrs. T. S. Lloyd, general superintendent of motive power, and C. A. Seley, mechanical engineer, representing the Rock Island System; W. A. Nettleton, general superintendent of motive power, representing the Frisco System, and Joseph H. Ames, of the American Car and Foundry Company, chairman, at which the work to be done by the committee was thoroughly discussed and a programme outlined. Following this, Mr. Henry La Rue, master car builder of the Rock Island at Chicago, and Mr. E. B. Schofield, general foreman of the car department of the Frisco System at Springfield, Mo., were detailed by Messrs. Lloyd and Nettleton respectively to act as permanent members of the committee and they, together with the chairman, began on August 25th, an examination in detail of the equipment. This inspection work occupied the committee until September 25th, and during this time practically every type of construction was examined; the condition of the car and recommendations as to its improvement or retirement being discussed and noted at the time of examination.

During the same period the clerical forces of the superintendents of motive power were engaged in compiling lists of the equipment, giving the number of each class of car in service, together with the age, capacity and original cost. Based on these lists, diagrams showing the composition of the equipment and its age, and tables showing the original cost and its present value, after deducting a constant annual depreciation, were prepared. A detailed list of each series of cars with the recommendations of the committee as to its improvement or retirement was also prepared, with tables showing original and depreciated value of equipment that should be retired from service at the earliest practicable date.

It is the opinion of the committee that all equipment of less than 60,000 lbs. capacity is, owing to its age and light construction, not safe to operate in the present heavy trains, owing to its liability to having the draft rigging pulled out, or the sills broken, permitting the car to buckle up or break down, when placed between modern high capacity cars; thereby causing damage to other cars, as well as an interruption to traffic by the wrecking of trains.

Further than this, the ratio of revenue earning load to dead weight hauled is too low for economical operation as compared with cars of higher capacity, being as follows:

Lbs.	Box.	Stock.	Coal.	Flat.
30,000	1.3 :1	1.3 :1	1.6 :1	1.7 :1
40,000	1.6 :1	1.6 :1	1.8 :1	2 :1
50,000	1.3 :1	1.8 :1	2.1 :1	2.5 :1
60,000	1.9 :1	1.3 :1	2.1 :1	2.5 :1
80,000	2.2 :1	None	2.5 :1	2.8 :1

An examination of the records will demonstrate that the principal item of expense for car repairs consists of the maintenance of these light capacity cars, and the early retirement of these cars would accomplish a large reduction in the expenditures for car repairs.

Many of these light cars have come to the systems by the purchase of roads having their own standards for equipment, hence there is a great variety of materials to be carried in stock for their maintenance, and unless a complete assortment is carried at each repair point, delays are sure to occur while waiting for necessary materials to be transferred from one point to another.

The committee recommends the adoption of a standard for every possible part, and whenever cars under repair require the replacement of any or all of such parts, that the standard decided upon be applied, instead of maintaining the original construction, which will gradually reduce the diversity and amount of material now necessarily carried in stock, and simplify and cheapen the work of repairs.

For all equipment constructed in the future, the committee recommends the use of all steel underframe and steel skeleton superstructures; the floor, sheathing, lining and roofing of closed cars and the sides, ends and floors of open cars to be of wood, as the trend of prices for lumber is upwards, and for steel is downwards; therefore, the cost of maintenance of steel cars would be less and of wooden cars would be greater, before the expiration of the useful life of a car built at the present time.

The designs presented by the committee have been worked out with regard for simplicity in original construction and ease in making repairs, as the central idea, and to be as low in dead weight as is consistent with safety.

The capacity recommended for box, furniture, refrigerator, fruit and stock cars is 60,000 lbs., as the conditions of traffic do not justify the use of a higher capacity; 80,000 lbs. for gondola and flat cars, and 100,000 lbs. for hopper or other types of self-clearing cars.

The ratios of revenue earning load to dead weight hauled for cars built to these designs would be as follows: Box, 2.1 to 1; stock, 2.2 to 1; coal, 2.5 to 1; flat, 2.8 to 1.

The maintenance of cars built to these designs would not call for any machinery not already in use in the various shops of the system, commercial sizes of rolled plates and shapes only being employed.

As many of the cars still bear the initials and serial numbers of the roads originally owning them, and therefore many numbers are duplicated, by reason of which there is liability of confustion in reporting cars, the committee recommends that the equipment be classified and renumbered in such a way that the number may indicate the class, and the class symbol the capacity and construction of the car.

(To be continued.)

RESULTS FROM THE COAL TESTING PLANT.

The preliminary report on the coal tests made on the plant of the United States Geological Survey, at St. Louis, contains much information not heretofore available. Among the results already clearly indicated by these preliminary tests the following may be stated as worthy of special consideration:

(1) The tests in the steam-boiler plant of 65 carload samples of coal from 17 states indicate the high steam-producing capacity of American coals, and that the quality of many of these coals may be improved by washing.

(2) Most of the American bituminous coals and lignites can be used as a source of power in a gas-producer plant.

(3) As indicated by comparative tests of 14 bituminous coals from 9 states, the power efficiency of these coals when used in the gas-producer plant is two and one-half times greater than their efficiency when used in the steam-boiler plant; or, in other words, 1 ton of these coals used in the gas-producer plant has developed, on a commercial scale, as much power as 2½ tons of the same coal when used in the ordinary steam-boiler plant.

(4) Some of the lignites from undeveloped but extensive deposits in North Dakota and Texas, when tested in the gas producer and gas engine, have shown unexpectedly high power-producing qualities, such as promise large future developments in those and other states.

(5) Some of the American coals, and the "slack" produced in mining these coals, can be briquetted on a commercial basis.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

In July, 1902, a policy of standardization of the entire locomotive equipment of the railroads known as the Harriman Lines was inaugurated. The roads concerned are the Union Pacific, Oregon Short Line, the Oregon Railroad & Navigation Company, Southern Pacific, the Chicago & Alton and the Kansas City Southern, comprising about 18,000 miles, and now operating more than 3,000 locomotives and 90,000 freight cars. The policy is a part of a plan which has been applied by Mr. Harriman in unifying practice, as far as practicable, throughout these lines. The director of maintenance and operation has had charge of the practice included under these heads, and the director of purchases, in conjunction with him and the general managers and the superintendents of motive power of these lines, has standardized all classes of locomotives, freight cars and passenger cars, including every detail. Complete specifications are made standard for locomotives and cars, reducing the purchasing to the simplest possible terms. To indicate the economical advantages of this standardization is the purpose of a series of articles on the complete locomotive standards, these being the most important development of the kind on any railroad. At the present time 366 of the standard locomotives are in service. That these standards are likely to influence the practice of other roads is indicated by the fact that 37 locomotives of the standard 2—8—0 type are now being built for the Erie Railroad.

As a result of the earlier work in this direction by the motive power officials of these roads, a number of standard details were agreed upon, and were illustrated in this journal in June, 1902, page 166. Further development has includ so many additional details that the entire subject is no taken up anew, the details having been decided upon aft numerous meetings of all the motive power and executiv officials.

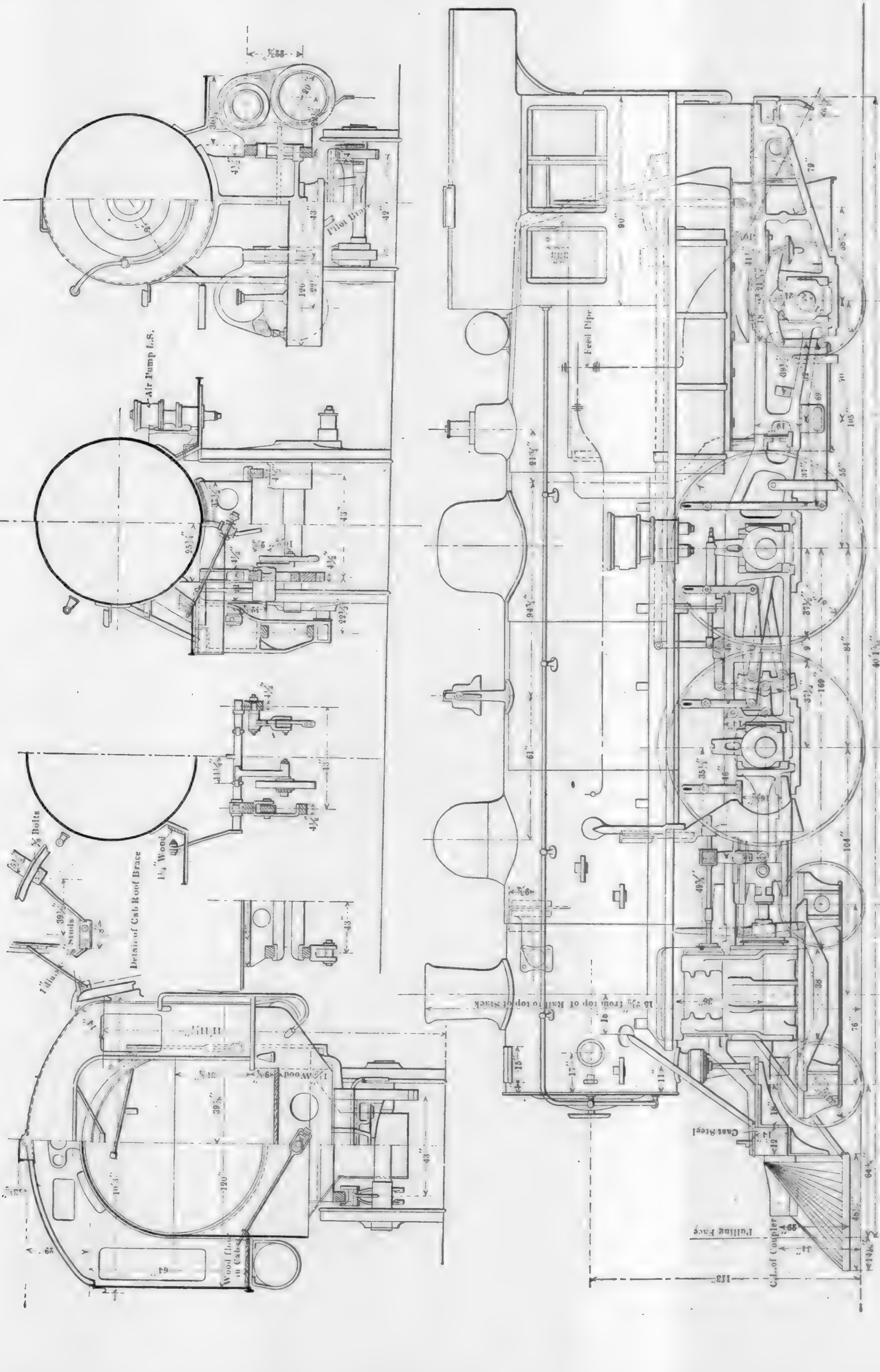
Four types are adopted for future construction, as follows Atlantic type passenger, Pacific type passenger, consolidatio freight and heavy switcher. It is intended to provide for a the demands of the immediate future from these four design The existing equipment provides a sufficient number of ligh locomotives for many years to come. From time to time ex perimental designs will be tried, with a view of adopting new standards whenever the advantages to be gained thereby ar sufficient. For example, an experimental application of th 4-cylinder balanced compound principle is to be made wit four locomotives of the 4—6—2 type now building at the Baldwin Works for the Oregon Railroad & Navigation Company.

Side elevations, and sections of the four standard types, together with a list of comparative dimensions and ratios are presented in this article, and discussions of the details will follow. An idea of the scope of the standardization is given in the following summary, which does not attempt to include all of the minor details:

The tenders for passenger engines will have 9,000-gal. tanks and provide for 12 tons of coal. They are of rectangular construction, whereas the freight engines will have Vanderbilt tenders, with cylindrical tanks of 7,000 gals. and 14 tons coal capacity. The switch engines have a special sloping tender of 4,000 gals. and 6 tons coal capacity. The cabs are the same for the various types, modified slightly to fit the different boilers. These will be shown in detail. In general terms,

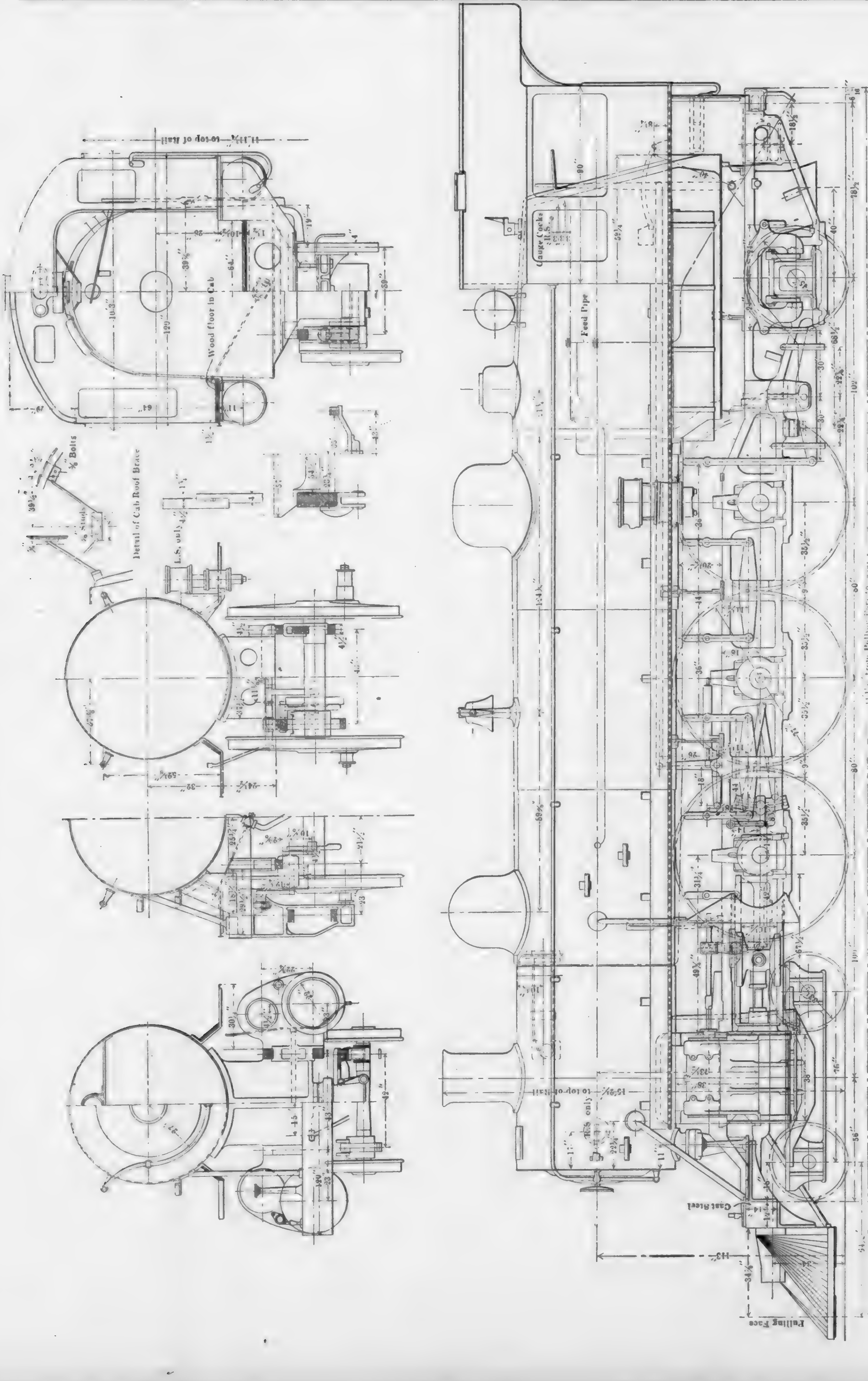
COMMON STANDARD COAL BURNING LOCOMOTIVES.
COMPARATIVE DIMENSIONS AND WEIGHTS.

Type	Atlantic.	Pacific.	Heavy Consol.	Switch.
Class	A-105	P-141	C-187	S-150
Common Standard Specification	101	102	103	106
RATIOS—				
Heating surface to volume of cylinder	260.7	248.	270.	179.5
Adhesive weight to heating surface	39.7	46.1	55.	82.
Adhesive weight to tractive effort	4.48	4.7	4.32	5.37
Tractive effort to adhesive weight, per cent	22.2	21.2	23.1	18.2
Tractive effort by diameter of drivers to heating surface	717.	754.	726.	873.
Heating surface to tractive effort, per cent	11.2	10.3	7.84	6.5
Total weight to heating surface	73.	72.	61.	82.
Heating surface to grate area	53.6	61.	69.	60.3
Weight taken with three gauges of hot water, coal fire, sand and two men—				
Weight on front drivers, about	53,000 lbs.	48,000 lbs.	47,600 lbs.	49,100 lbs.
Weight on intermediate drivers, about	......	......	45,300 "	53,400 "
Weight on main drivers, about	52,000 "	45,000 "	48,700 "	47,500 "
Weight on back drivers, about	......	48,000 "	45,400 "	......
Weight, total, on drivers, about	105,000 "	141,000 "	187,000 "	150,000 "
Weight on truck, about	45,000 "	37,000 "	21,000 "	......
Weight on trailer, about	46,000 "	44,000 "	......	......
Weight, total, of engine, about	196,000 "	222,000 "	208,000 "	150,000 "
Driving wheel base	7 ft.	13 ft. 4 ins.	15 ft. 8 ins.	11 ft. 4 ins.
Wheel base of engine	27 ft. 7 ins.	33 ft. 4 ins.	24 ft. 4 ins.	11 ft. 4 ins.
Wheel base of engine and tender	58 ft. 2 ins.	63 ft. 10½ ins.	55 ft. 11¾ ins.	42 ft. 9 ins.
Height top of rail to top of stack	15 ft. 2½ ins.	15 ft. 2½ ins.	15 ft. 2½ ins.	14 ft. 4½ ins.
Height of cab at eaves above top of rail to center of eave radius	11 ft. 11¼ ins.	11 ft. 11¼ ins.	11 ft. 11¼ ins.	11 ft. 4¾ ins.
Width of cab over shields	10 ft. 3 ins.	10 ft. 3 ins.	10 ft. 3 ins.	10 ft. 3 ins.
Width of cab over eaves	10 ft.	10 ft.	10 ft.	10 ft.
Width over cylinder casing	9 ft. 8¼ ins.	9 ft. 10¼ ins.	9 ft. 10¼ ins.	9 ft. 6¾ ins.
Center line of boiler from top of rail	9 ft. 5 ins.	9 ft. 5 ins.	9 ft. 6 ins.	8 ft. 7 ins.
Center to center of cylinders	88 ins.	89 ins.	89 ins.	88 ins
Center to center of frames	43 ins.	43 ins.	43 ins.	43 ins.
Cylinders	20 x 28	22 x 28	22 x 30	20 x 26
Driving wheels, outside diameter	81 ins.	77 ins.	57 ins.	57 ins.
Driving wheel centers, outside diameter	74 ins.	70 ins.	50 ins.	50 ins.
Engine truck wheels, diameter	33½ ins.	33½ ins.	30½ ins.	......
Trailing truck wheels, diameter	51 ins.	45 ins.	......	......
Tractive power (M. E. P. 85 per cent. of boiler pressure)	23,506	29,920	43,299	27,915
Fire box	108 in. x 66 in.	108 in. x 66 in.	108 in. x 66 in.	108 in. x 40¼ in.
Grate area, square feet	49.5	49.5	49.5	30.2
Heating surface of tubes, square feet	2,475	2,874	3,266	1,650
Heating surface of firebox, square feet	180	180	171	172
Total heating surface	2,655	3,054	3,397	1,822
Boiler, smallest o. d. diameter, inches	70	70	80	70
Tubes, number and diameter, in inches	297-2	245-2¼	413-2	276-2
Tubes, length, in feet	16	20	15	11½
Boiler pressure, lbs.	200	200	200	180
Valve, type	Piston	Piston	Piston	Am. Bal.
Valve, travel	6 ins.	6 ins.	6 ins.	6 ins.
TENDER, Type	Rectangular	Rectangular	Cylindrical	Rectangular, Sloping
Coal capacity, level full, tons	10	10	14	6
Water capacity, gallons	9,000	9,000	7,000	4,000
Weight of tender, empty	54,400 lbs.	54,400 lbs.	48,720 lbs.	39,770 lbs.
Weight of tender, water carried	75,000 "	75,000 "	58,330 "	33,330 "
Weight of tender, coal carried	20,000 "	20,000 "	28,000 "	12,000 "
Weight of tender, loaded	149,400 "	149,400 "	135,050 "	85,100 "
Weight of tender truck	9,975 "	9,975 "	9,975 "	6,800 "



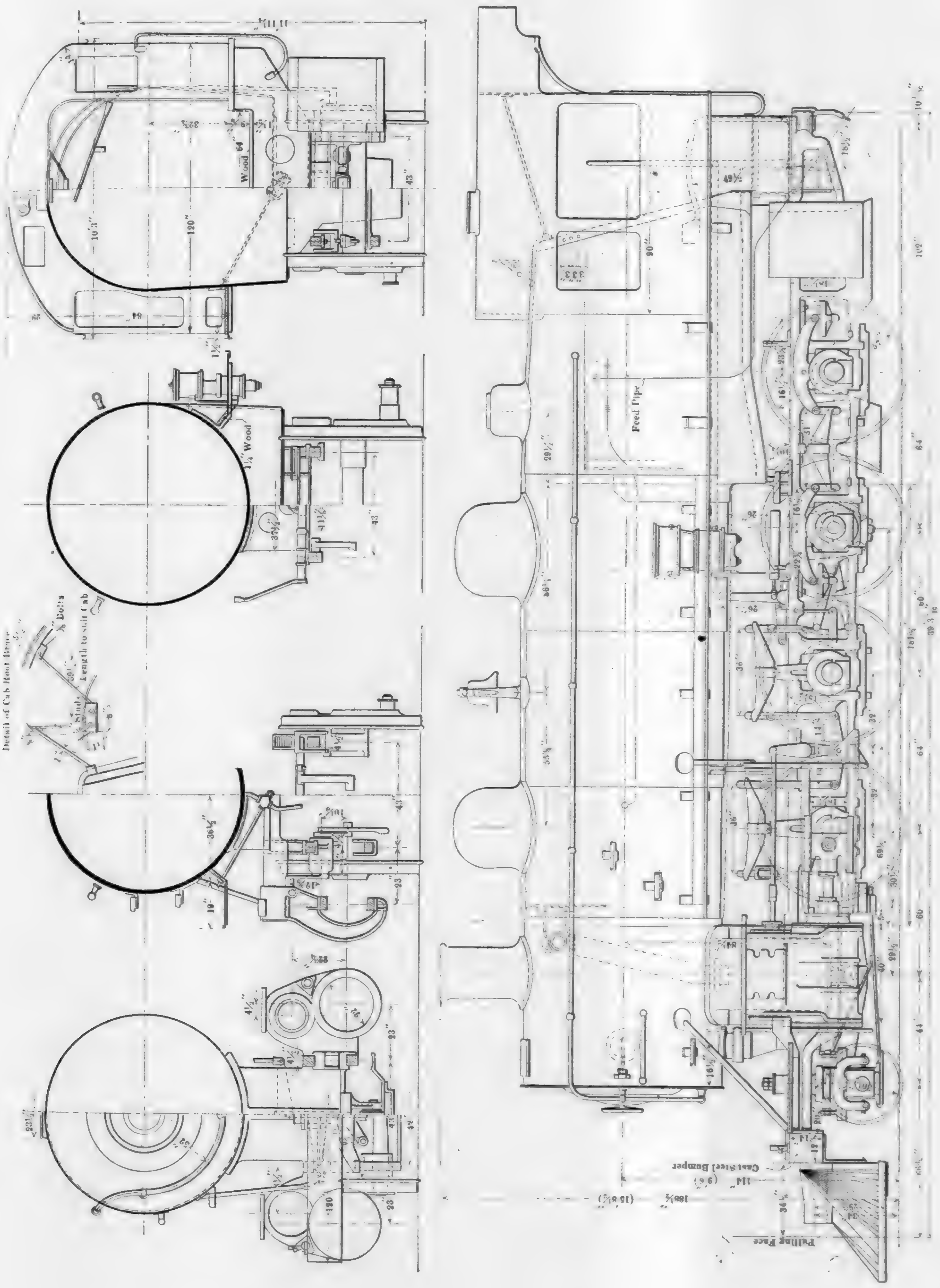
4—4—2 (ATLANTIC) TYPE PASSENGER LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.



4—6—2 (PACIFIC) TYPE PASSENGER LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.



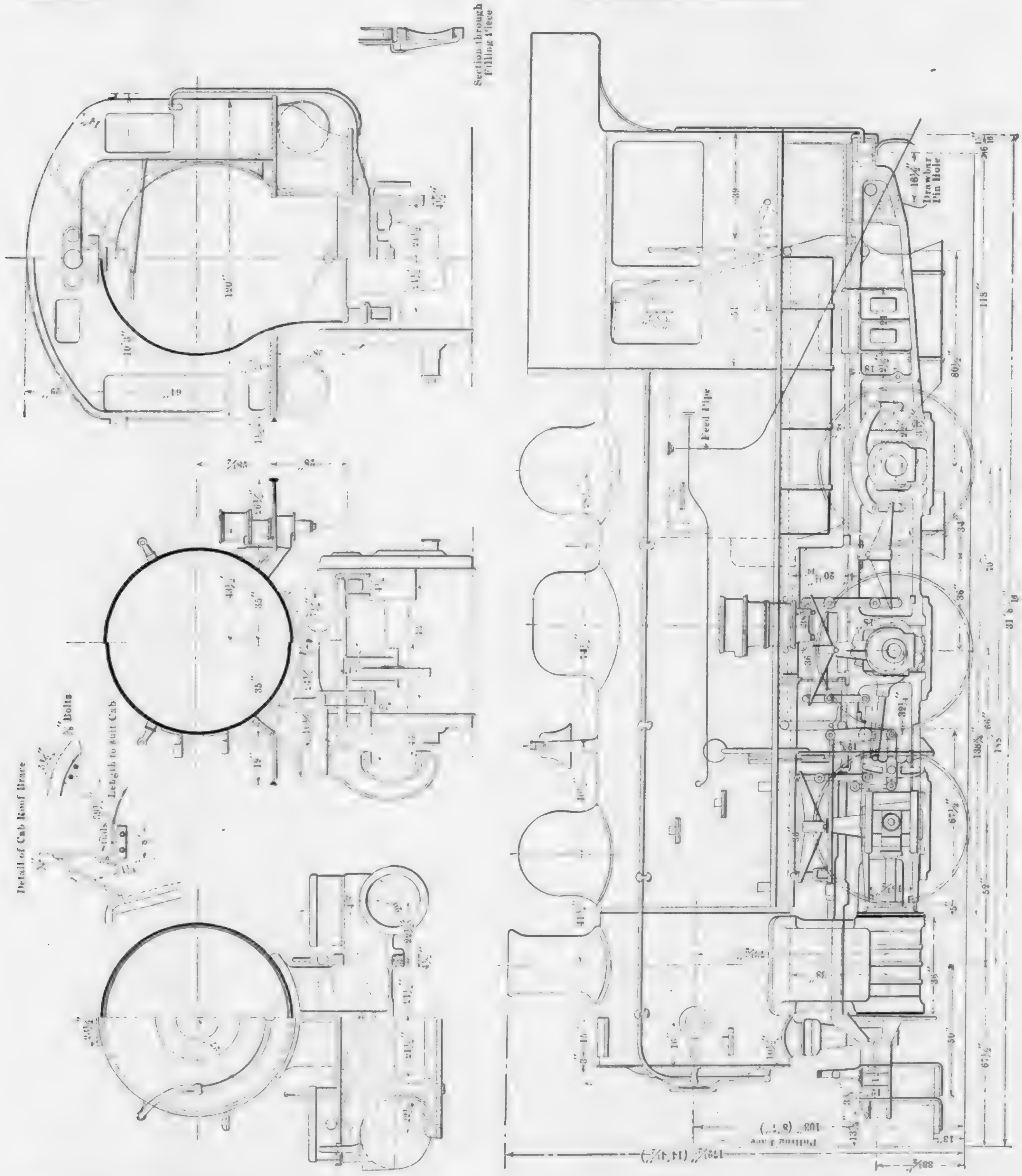
2—8—0 (CONSOLIDATION) FREIGHT LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.

the following parts are common to all the locomotives, special mention being made of those which are modified for the switch engines:

STANDARDS COMMON TO ALL NEW LOCOMOTIVES.

Driving boxes and brasses.
Locomotive truck boxes and brasses.
Locomotive truck axles.
Smoke stacks.
Bells and sand boxes.
Air bell-ringer.
Pilots (except switchers).
Deck plates.
Front journals on main rods.
Front and back journals on side rods.
Crank pin brasses varied as follows:
Back end of main rod (Pacific and Consolidation).
Back end of main rod (Atlantic and Switcher).
Couplers (except front of switcher).
Dome bases, rings and caps.
Headlights.
Auxiliary domes (except switcher).
Cocks, valves and oil cups.
Tank hose (different length on switcher).
Brake shoes.
Eccentrics and eccentric straps.



SIX-WHEEL SWITCHING LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.

Cast steel front bumpers (except switchers).
Coupling bars (except switchers).
Spring buffers between engines and tenders.
Tender journal boxes (except switcher).
Cab brackets (except switchers).
Cab fittings.
Cinder hoppers.
Exhaust pipes and tips (tips of various sizes).
Cross heads.
Feed-pipe strainers and couplers.
Steam chest valves. (Piston on road engines. American balance on switcher.)
Grate casting (except switcher).
Piston rods (of 4 ins. in diameter, two lengths).
Piston rod packing (U. S. Metallic).
Valve steam packing (U. S. Metallic).
Links and saddles (radius varies).
Rocker shaft bearings.
Tender truck complete (except switcher).
Throttle valve and throttle dry-pipe ends.

...rottle levers and stuffing boxes.
...fety valves.
...ater gauge, Klinger reflex.
...jectors (No. 10 Nathan Monitor road, No. 9 switcher).
...ubricators (Nathan Bull's Eye).
...histles (chime on passenger, plain on freight).
...moke box doors.
...am gauges.
...ring saddles.
...ash-out plugs.

...great many of the minor details which are common to ... or more designs and not common to all are not mentioned ... this list. The parts listed include all of the most important ...atures of the standardization. In the detailed description ...e most important parts will be discussed separately.

The courtesy of Mr. W. V. S. Thorne, director of purchases, ... supplying this information is acknowledged, and that of ...he Baldwin Locomotive Works in supplying the drawings.

A SHOP SCHEDULE FOR LOCOMOTIVE REPAIRS.

Mr. Henry Gardner, assistant master mechanic of the Boston & Maine Railroad, has introduced into the Concord shops of that road a shop schedule, which is illustrated by means of the accompanying blank forms:

The object of scheduling or dating locomotive parts in a large railroad repair shop is at once seen when the proper delivery of all the parts needing general repair, for say, 20 or 30 locomotives, is considered. These many parts must, in general, go through the same process for all engines having the same class of repairs, and must follow the same route or course through the various departments. It is evidently out of the question for any one man, however retentive his memory, to follow all this material so that it will be delivered to the erecting shop when needed for the engine, and, therefore, some system must be employed to avoid unnecessary delays.

This system simply assigns to each part of the engine a proper date or day of the month when this part must be sent to, received at, and delivered in turn to the various departments comprising the route over which it is to travel. These parts all start from the erecting shop after the engine is stripped, and return to the erecting shop when wanted for final application.

Sheet No. X.

SCHEDULE SHEET.

Engine No. X. — Date taken into Shop, X, '05.
Class, X. — Date to leave Shop, X, '05.
Class of Repairs, C. — Time allowed, 25 days.

This form contains constants for use in making out the repair record sheets.

Class of Work.	Wanted in Machine Shop.	Wanted in Smith Shop.	Wanted in Boiler Shop.	Wanted in Cab Shop	Wanted in Paint Shop.	Wanted in Erecting Shop.	Received in Erecting Shop.	Remarks.
Boiler test (first)	..	..	2	..	..	2	..	..
Tender (first)	..	..	4	..	14	4	..	..
Cab	..	..	..	3	..	10	..	..
Valves and Yokes	2	3	..	..	..	10	..	..
Steam chests and covers	2	..	..	..	..	10	..	..
Tender springs	..	..	..	..	..	13	..	..
Spring rigging	..	2	..	..	..	16	..	..
Driver brake	..	2	..	..	..	16	..	..
Guides	2	..	..	..	..	16	..	..
Ash pan	..	..	3	..	..	18	..	..
Driving wheels	1	..	..	..	..	18	..	..
Eccentrics and straps	2	..	..	..	..	18	..	..
Cross-heads	2	..	..	..	..	19	..	..
Pistons and rods	2	..	..	..	..	19	..	..
Engine springs	..	..	..	..	..	19	..	..
Driving boxes, shoes, wedges	2	..	..	..	..	20	..	..
Link work	2	..	..	..	..	20	..	..
Main rods	0	..	..	..	..	20	..	..
Brass work	2	..	..	..	..	20	..	..
Flues set	..	..	20	..	..	20	..	..
Boiler work	..	..	20	..	..	20	..	..
Engine truck	..	..	..	..	..	20	..	..
Boiler test (last)	..	..	21	..	..	21	..	..
Smokebox work	..	..	22	..	..	22	..	..
Tender (last)	..	..	..	..	..	23	..	..
Parallel rods	0	..	..	..	..	23	..	..

The blank forms include a schedule sheet, date sheet, repair record sheet and shop repair cards. The date sheet or "Calendar" is used to quickly and accurately assign the dates as called for on the repair record sheet. This is done by means of the schedule sheet, which carries against the parts to be routed, numbers or constants, representing the increments of time between the receipt and delivery of these parts in the various departments concerned. The date sheet may be made for any number of months, and is merely a convenient aid in making out the repair record sheet. It may be made in the form of a slide rule, with the days of three months (Sundays and holidays omitted) on the fixed part, and numbers from 0 to 24, or the total number of days in the schedule on the sliding part. The 0 is placed under the day an engine comes into the shop and over the constants on the sliding part, the desired date when parts must be ready is read from the fixed part.

The schedule sheet is a counterpart of the repair record sheet but, instead of carrying actual dates, the corresponding spaces are used for the constants referred to. An engine may be allowed any number of days, the values of the constants varying in proportion to the total time.

The repair record sheet shows the names of the parts in the left-hand vertical column, and on the horizontal line at the top are headings for each department concerned. The shop repair card is a subdivision of the repair record sheet, and is used to extend the information on that sheet to the workmen who make the repairs to the different parts.

Sheet No. 201.

REPAIR RECORD SHEET.
Issued to
JOHN SMITH, Foreman.

Engine No. 2. — Date taken into Shop, 2—27—'05.
Class T—84—c. — Date to leave Shop, 3—27—'05.
Class of Repairs, C. — Time allowed, 25 days.

Class of Work.	Wanted in Machine Shop.	Wanted in Smith Shop.	Wanted in Boiler Shop.	Wanted in Cab Shop.	Wanted in Paint Shop.	Wanted in Erecting Shop.	Received in Erecting Shop.	Remarks.
Boiler test (first)	....	....	3–1	....	....	3–1	....	....
Tender (first)	....	....	3–3	....	3–15	3–3	....	....
Cab	....	....	....	3–2	....	3–10	....	....
Valves and yokes	3–1	3–2	....	....	....	3–10	....	....
Steam chests and covers	3–1	....	....	....	....	3–10	....	....
Tender springs	....	....	....	....	....	3–14	....	....
Spring rigging	....	3–1	....	....	....	3–17	....	....
Driver brake	....	3–1	....	....	....	3–17	....	....
Guides	3–1	....	....	....	....	3–17	....	....
Ash pan	....	....	3–2	....	....	3–20	....	....
Driving wheels	2–28	....	....	....	....	3–20	....	....
Eccentrics and straps	3–1	....	....	....	....	3–20	....	....
Cross-heads	3–1	....	....	....	....	3–21	....	....
Pistons and rods	3–1	....	....	....	....	3–21	....	....
Engine springs	....	....	....	....	....	3–21	....	....
Driving boxes, shoes, wedges	3–1	....	....	....	....	3–22	....	....
Link work	3–1	....	....	....	....	3–22	....	....
Main rods	2–27	....	....	....	....	3–22	....	....
Brass work	3–1	....	....	....	....	3–22	....	....
Flues set	....	....	3–22	....	....	3–22	....	....
Boiler work	....	....	3–22	....	....	3–22	....	....
Engine truck	....	....	....	....	....	3–22	....	....
Boiler test (last)	....	....	3–23	....	....	3–23	....	....
Smokebox work	....	....	3–24	....	....	3–24	....	....
Tender (last)	....	....	....	....	....	3–25	....	....
Parallel rods	2–27	....	....	....	....	3–25	....	....

This Sheet to be returned to the Master Mechanic's Office when the Engine goes into service.

F. E. Brown, M. M.

These sheets and cards are used in the following manner in these shops, although, of course, no two shops would employ the same methods, due to the differences in arrangement and classification of buildings and machines. The repair record sheet is first filled out by the master mechanic, and issued to the foremen of the different departments; each foreman receiving a duplicate sheet bearing all dates for the entire engine. From this each foreman issues the shop repair cards to the head men on the different jobs, or classes of work, which come under his jurisdiction. At Concord 12 of these cards

are issued for each engine, covering practically all parts as given on the repair record sheet.

In filling in the dates, for example, the "main rods" on the repair record sheet for Engine No. 2 are wanted in the machine shop February 27 (2—27), and in the erecting shop ready for the engine, 3—22. Referring to the schedule sheet for 25 days (the number of days allowed this engine), the constant 0 is found in the corresponding space for "main rods" "wanted in machine shop," and the constant 20 is found in the space for "main rods" "wanted in erecting shop." Turning to the date sheet (or slide rule), put 0 under the date 2—27, when the engine came in, and on the same horizontal line in numerical order write the numbers from 0 to 24, or one less than the total number of days given by the schedule.

1905. No. 748.

SHOP REPAIR CARD.

Issued to F. E. RICHARDS, Foreman. Engine No. 2.

Class of Work	Wanted in Erecting Shop. (First.)	Wanted in Paint Shop.	Sent to Paint Shop.	Wanted in Erecting Shop. (Last.)	Remarks.
Tender	3—3	3—15	....	3—25	....
Engine truck. ..	....	.....	....	3—22	....

This card to be filled out and returned to the Foreman's Office and then sent to the Master Mechanic's Office at once.

JOHN SMITH, Foreman.

1905. No. 802.

SHOP REPAIR CARD.

Issued to M. ANDERSON, Foreman. Engine No. 2.

Class of Work	Wanted in Cab Shop.	Received in Cab Shop.	Wanted in Erecting Shop.	Wanted in Paint Shop.	Date Finished.
Cab and Run. Boards	3—2	....	3—10	.....	....
Tender	....	....	3—3	3—15	....

This card to be filled out and returned to the Master Mechanic's Office at once. Write any explanation on back of card.

F. E. BROWN, M. M

1905. No. 2,014.

SHOP REPAIR CARD.

Issued to W. JONES. Engine No. 2.

Class of Work.	Wanted in Machine Shop.	Received in Machine Shop.	Wanted in Erecting Shop.	Date Finished.	Remarks.
Valves	3—1	....	3—10	....	....
Yokes	3—1	....	3—10	....	....
Steam chests	3—1	....	3—10	....	....
Steam chest covers	3—1	....	3—10	....	....
Guides	3—1	....	3—17	....	....

This card to be filled out and returned to the Foreman's Office, and then sent to the Master Mechanic's Office at once.

JOHN SMITH, Foreman.

Then, reading up over 0, the date 2—27 and, reading up over 20, the date 3—22 is found. It will be seen that Sundays and holidays are omitted, since working days only are considered. In the same manner the proper date corresponding to a constant of any value from 0 to 24 may be quickly read from this sheet (or slide rule).

The values of the constants on the schedule sheet were obtained by comparing records of the average time required to do each class of work. These results were then checked and altered as necessary to produce the best results in practice. Each engine of a class should have the same schedule.

The column "Remarks—Cause for Delay, Etc." on the repair record sheet may be omitted after the repairs are running smoothly in their allotted times. On first using this system, however, these causes for delay, if honestly given by the foremen, will greatly help to equalize the shop, that is, to bring up a weak department by adding men or machines, as necessary. In this manner an equilibrium can finally be obtained which will produce the best results. The column headed "Received in Erecting Shop" is filled in by the erecting shop foreman as the work is received.

A few apparent advantages resulting from using this system are given as follows:

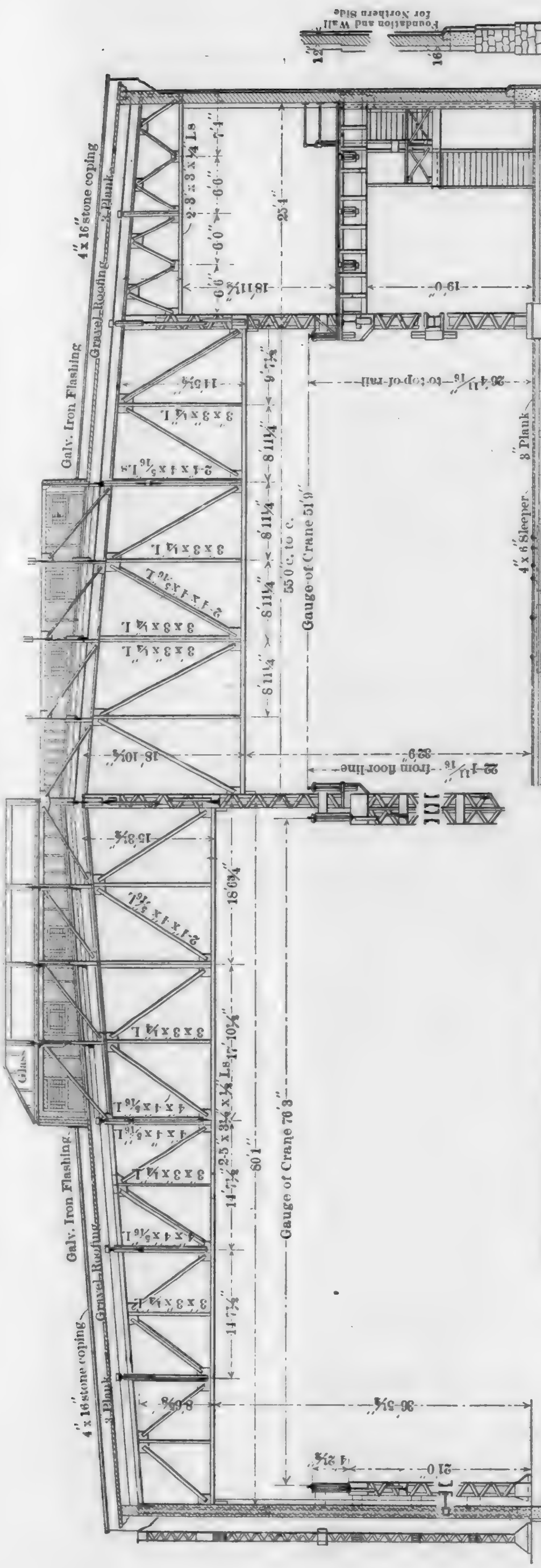
(1) The shops may be equalized, as already stated, departments deficient in men or tools may be adjusted or balanced to produce the best results. (2) Friction between foremen and sub-foremen in different departments may be avoided, since the shop repair card dictates when any part will be finished and delivered. (3) The men are stimulated in their work from the fact that some take an interest in keeping their dates while others have continually the knowledge that delays in their department are known and recorded at headquarters. (4) The increased output always noticeable where systematic methods are employed for doing work.

The schedule of the Chicago & Northwestern Railway at Chicago was illustrated in this journal in February, 1904, page 58, and in March, 1905, page 73, some of the results obtained by its use were recorded.

Tire Steel Insufficiently Worked.—In an admirable paper before the International Railway Congress, Mr. P. H. Dudley shows from an exhaustive study that tire steel is inferior to rail steel in wearing qualities because it is not sufficiently worked. It has a "cell hardness," instead of a "mass hardness," and lacks the interlocked and fine structure of rail steel. While greater care is taken with tire than with rail ingots, still more attention is necessary to secure the desired solidity, first in the ingots, and second, in the manufacture. This is evident from failures of trailing wheel tires of Atlantic type engines, with loads of 38,000 lbs. per axle. These tires have flattened from crushing, due to slight porosity and unsoundness. These tires are made from 12-sided ingots, in the angles of which unsoundness developed in cooling. They contained 0.62 to 0.67 of carbon, 0.65 to 0.78 of manganese, 0.20 to 0.26 silicon and 0.06 phosphorous. They were hard on the surface from working, but coarse and fragile beneath. The weakness corresponded to some of the corners of the ingots. Trailing tires of 50-in. do not show as good results as 79-in. driving tires on the same engine, because the smaller tires received less work in manufacture. After wear begun its destruction was rapid and dangerous to the track. Tensile tests of small test ingots do not lead to securing the grade of steel desired in tires of varying diameters.

Differential Piece Rate System.—The differential rate system consists in fixing for any piece of work two rates, one about 20 per cent. higher than the other. If the work is done in the time in which the study indicates that a good man fitted for the work and working at his best normal speed can do it, or in less time, the rate paid is the high one. If the time taken is longer than this, the lower rate is paid. To take a concrete example, let us suppose that a man can turn ten axles in a day on a certain lathe and the high rate is 30 cents each. If nine or less are done he gets only 25 cents each. His pay then for 10 is $3 and for 9 $2.25. The difference between the pay for 9 and that for 10 is thus so great that a workman will make every effort to do the 10 if he has a fair chance of success.—*H. L. Gantt, in Engineering Magazine.*

Small Things Bought by Railroads.—The Santa Fe uses every year one and a half tons of pins, 25 miles of lead pencils, 396,000 steel pens, 50 barrels of ink, 13,000 lbs. of rubber bands, 15 carloads of stationery, 26,000 brooms.



CROSS-SECTION OF LOCOMOTIVE SHOP.

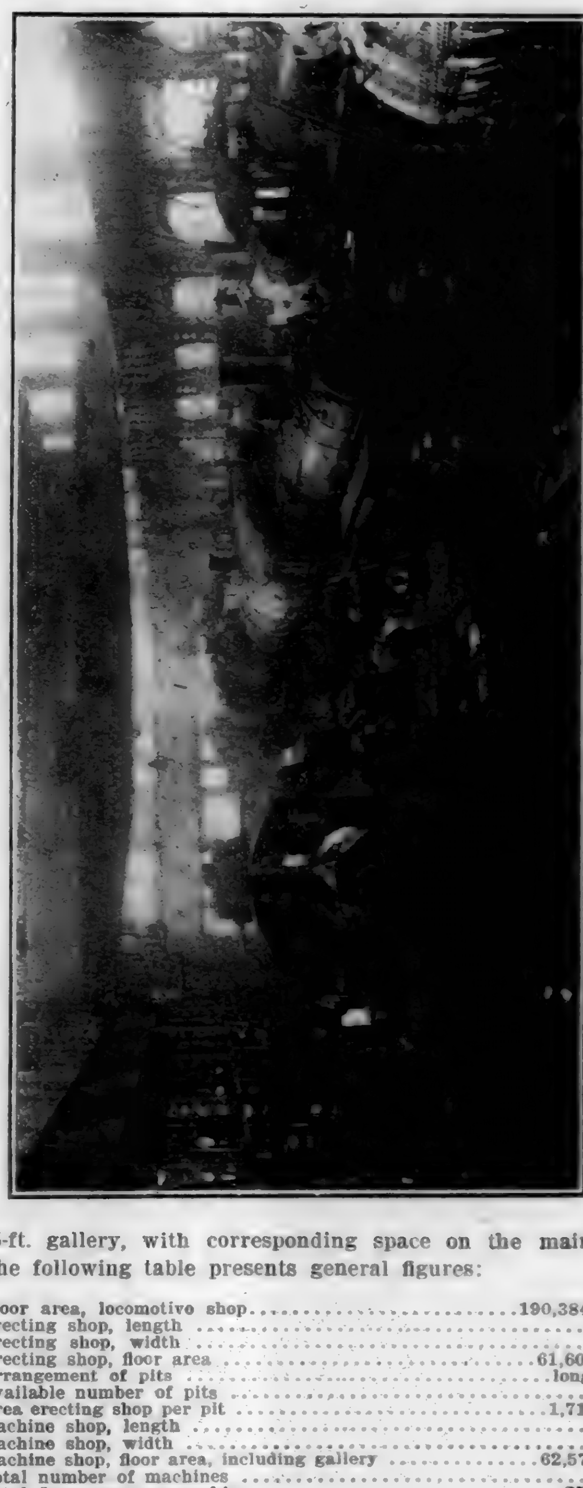
ANGUS LOCOMOTIVE SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

VI.

(*For previous article see page* 114.)

The erecting, machine and boiler departments are provided for in a building 1,167 ft. long by 162 ft. 8 ins. wide, a cross-section and plan of which are shown in the accompanying engraving, to which are added several interior views. The erecting shop is a bay 80 ft. wide; the machine shop is a bay 55 ft. wide, and at one side the full length of the shop is a



INTERIOR OF LOCOMOTIVE SHOP, SHOWING ERECTING BAY.

ANGUS SHOPS—CANADIAN PACIFIC RAILWAY, MONTREAL.

25-ft. gallery, with corresponding space on the main floor. The following table presents general figures:

Floor area, locomotive shop	190,384 sq. ft.
Erecting shop, length	770 ft.
Erecting shop, width	80 ft.
Erecting shop, floor area	61,600 sq. ft.
Arrangement of pits	longitudinal
Available number of pits	36
Area erecting shop per pit	1,711 sq. ft.
Machine shop, length	770 ft.
Machine shop, width	80 ft.
Machine shop, floor area, including gallery	62,575 sq. ft.
Total number of machines	245
Total floor area per machine	255 sq. ft.
Machine shop area per pit	1,738 sq. ft.
Boiler shop, length	395 ft.
Boiler shop, width	80 ft.
Boiler shop, floor space	31,600 sq. ft.
Boiler shop, number of machines	39
Boiler shop, floor area per erecting shop pit	877 sq. ft.

The plan of the locomotive shop is shown in three sec-

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In filling in the dates, for example, the "main rods" on the repair record sheet for Engine No. 2 are wanted in the machine shop February 27 (2—27), and in the erecting shop ready for the engine, 3—22. Referring to the schedule sheet for 25 days (the number of days allowed this engine), the constant 0 is found in the corresponding space for "main rods" "wanted in machine shop," and the constant 20 is found in the space for "main rods" "wanted in erecting shop." Turning to the date sheet (or slide rule), put 0 under the date 2—27, when the engine came in, and on the same horizontal line in numerical order write the numbers from 0 to 24, or one less than the total number of days given by the schedule.

1905. No. 748.

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Class of Work	Wanted in Erecting Shop (First.)	Wanted in Paint Shop.	Sent to Paint Shop	Wanted in Erecting Shop. (Last.)	Remarks.
Tender	3—3	3—15	...	3—25	... ...
Engine truck. ..	....	.	.	3—22	....

This card to be filled out and returned to the Foreman's Office and then sent to the Master Mechanic's Office at once.

JOHN SMITH, Foreman.

1905. No. [illegible]

SHOP REPAIR CARD.

Issued to M. ANDERSON, Foreman. Engine No. 2

Class of Work	Wanted in Cab Shop	Received in Cab Shop	Wanted in Erecting Shop.	Wanted in Paint Shop	Date Finished.
Cab and Run. Boards	3—2	....	3—10	.....	... ...
Tender	....	....	3—3	3—15	......

This card to be filled out and returned to the Master Mechanic's Office at once. Write any explanation on back of card.

F. E. BROWN, M. M.

1905. No. 2,014.

SHOP REPAIR CARD.

Issued to W. JONES. Engine No. 2.

Class of Work.	Wanted in Machine Shop	Received in Machine Shop.	Wanted in Erecting Shop	Date Finished	Remarks.
Valves	3—1	....	3—10		....
Yokes	3—1	..	3—10	.	....
Steam chests	3—1	.	3—10	.	.
Steam chest covers	3—1		3—10		
Guides	3—1	....	3—17	.	... .

This card to be filled out and returned to the Foreman's Office, and then sent to the Master Mechanic's Office at once.

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DIFFERENTIAL PIECE RATE SYSTEM.—The differential rate system consists in fixing for any piece of work two rates, one about 20 per cent. higher than the other. If the work is done in the time in which the study indicates that a good man fitted for the work and working at his best normal speed can do it, or in less time, the rate paid is the high one. If the time taken is longer than this, the lower rate is paid. To take a concrete example, let us suppose that a man can turn ten axles in a day on a certain lathe and the high rate is 30 cents each. If nine or less are done he gets only 25 cents each. His pay then for 10 is $3 and for 9 $2.25. The difference between the pay for 9 and that for 10 is thus so great that a workman will make every effort to do the 10 if he has a fair chance of success.—*H. L. Gantt, in Engineering Magazine.*

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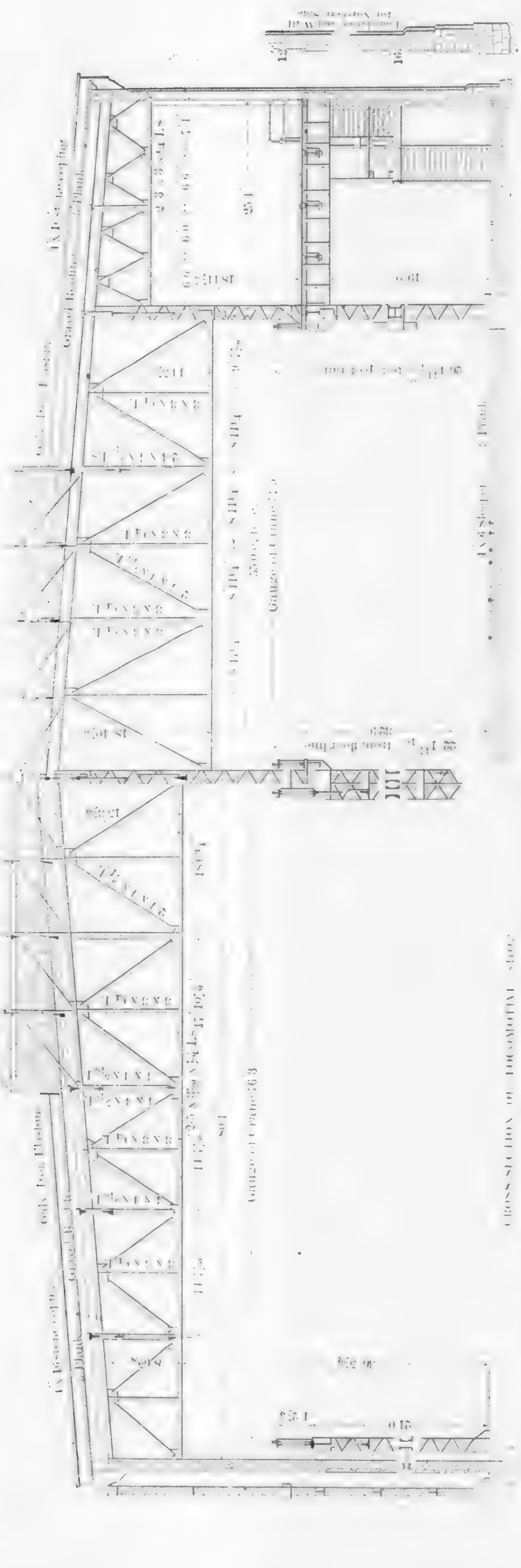

CROSS SECTION OF LOCOMOTIVE SHOP.

ANGUS LOCOMOTIVE SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

VI

(For previous article see page 114.)

The erecting, machine and boiler departments are provided for in a building 1,167 ft. long by 162 ft. 8 ins. wide, a cross section and plan of which are shown in the accompanying engraving, to which are added several interior views. The erecting shop is a bay 80 ft. wide; the machine shop is a bay 55 ft. wide, and at one side the full length of the shop is a

INTERIOR OF LOCOMOTIVE SHOP, SHOWING ERECTING BAY. ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

25-ft. gallery, with corresponding space on the main floor. The following table presents general figures:

Floor area, locomotive shop	[illegible] sq. ft.
Erecting shop, length	770 ft.
Erecting shop, width	80 ft.
Erecting shop, floor area	61,600 sq. ft.
Arrangement of pits	longitudinal
Available number of pits	36
Area erecting shop per pit	1,711 sq. ft.
Machine shop, length	770 ft.
Machine shop, width	80 ft.
Machine shop, floor area, including gallery	62,575 sq. ft.
Total number of machines	245
Total floor area per machine	255 sq. ft.
Machine shop area per pit	1,738 sq. ft.
Boiler shop, length	395 ft.
Boiler shop, width	80 ft.
Boiler shop, floor space	[illegible] sq. ft.
Boiler shop, number of machines	39
Boiler shop, floor area per erecting shop pit	877 sq. ft.

The plan of the locomotive shop is shown in three sec-

tions. In the lower portion of the engraving are the three longitudinal tracks extending through the shop, which are located at 25-ft. centers, which is an unusual distance between tracks. This necessitates an erecting shop bay with a crane span of 76 ft. 3 ins. Between the pit tracks are two standard gauge supply tracks. In the plan the lower, or southern, track has a pit 762 ft. long. The center track has a pit 894 ft. long, and the upper track a short pit 454 ft. long, making a total pit length of 2,110 ft. For convenience in getting about the engines the standing space in the erecting shop is limited to about 36 engines, although this number is somewhat elastic. The building is lighted by high windows and by long transverse skylights over its central portion. The roof trusses and crane supports are illustrated in the sectional view. For protection against fire the entire building is equipped with automatic sprinklers, and galvanized iron fire curtains are built in the roof trusses down to a point which will clear the cranes. These are placed at every seventh roof truss.

millers and the truck wheel and axle box work. A bracket jib crane of 1,500 lbs. capacity, with a pneumatic cylinder, serves the axle work. Two 1,000-lb. pneumatic cylinder bracket cranes handle work to the millers, and planers and truck wheel tires. A 1,000-lb. pneumatic jib crane serves the axle box work, and a 4-ton pneumatic cylinder hand travelling crane is located over the lye cleaning tank. Special care was taken to plan the shop for convenience in handling material, which is a matter of great importance in a plant of this size.

By referring to the floor plan, the departments beginning at the east end of the machine floor are as follows: The wheel shop, including the tire setting, driving box work, truck shop, cylinder shop, piston cross-head department, opposite which is the frame shop; the next space is for side rods, and beyond this motion work. Next comes spaces for miscellaneous departments, such as air pumps, pipe shop, track and spring shop, scale repair shop, some of the latter departments being in the west machine shop. West of this is the boiler shop, providing for flue work and general boiler work, including

INTERIOR OF MACHINE SHOP, SHOWING TRANSVERSE BENCHES AND ROD RACKS.

ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

In addition to the tracks in the erecting shop, the machine shop has a supply track running its full length, and the shops have seven transverse supply tracks connected with an out-of-door track running the full length of the building. By the addition of light rails a double narrow gauge track is provided by using one of the light rails and one of the standard gauge rails on each side in an arrangement permitting small trucks to pass each other in opposite directions without switching either of the trucks to the side track. This arrangement is a novelty, which was described in detail in this journal in July, 1904, page 264. These extra rails are also provided for on the shop turn-tables.

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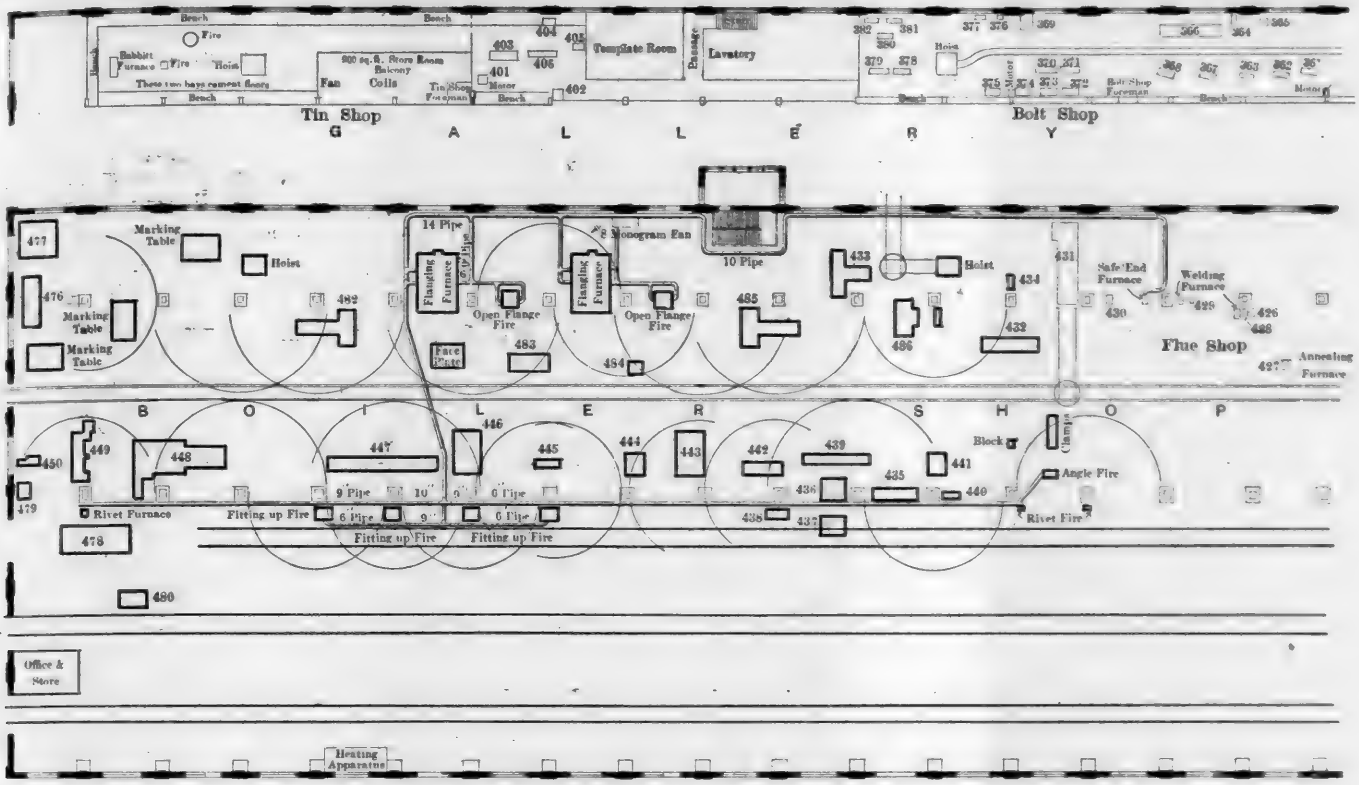

PLAN OF WEST END OF LOCOMOTIVE SHOP, SHOWING BOILER SHOP AND GALLERY.

ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

BOILER SHOP.

Power Machines.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
426	Swedging Hammer		Can. Pac. Ry.	Com. Air.
427	Tube Cutter		Can. Pac. Ry.	
428	Welding Machine		Hartz	15 A.C.
429	Welding Machine		Hartz	
430	Tube Cutter		Can. Pac. Ry.	
431	Tube Cleaner		Whiting Fdry. Co.	20 A.C.
432	Punch and Shears	Size "D"	Long & Allstatter	15 A.C.
433	Punch and Shears		Bertram	10 A.C.
434	Rotary Shears	¼-in. plate	Collier Co.	5 A.C.
435	Double Drill		Bertram	
436	Double Bolt Cutter	Acme 1½-in.	Bertram	
437	Triple Bolt Cutter	Acme 1½-in.	Bertram	
438	Vertical Drill	36-in.	Bertram	20 A.C.
439	Plate Planer	18-ft.	Craven Bros.	
440	Vertical Drill	24-in.	Smith & Coventry	
441	Mud Ring Drill	4 Spindles	Craven Bros.	
442	Small Plate Rolls	8 in.x7 ft.	Craven Bros.	
443	Flue Sheet Drill	2 Spindles	Bertram	7.5 A.C.
444	Flue Sheet Drill	2 Spindles	Craven Bros.	
445	Horizontal Punch		Berry & Co.	7.5 A.C.
446	Flue Sheet Drill	3 Spindles	Bertram	5 A.C.
447	Plate Planer	25-ft.	Bertram	15 A.C.
448	Large Plate Roll	16 in.x12 ft.	Bertram	30 A.C.
449	Mud Ring Drill	6 Spindles	Bement Miles	7.5 A.C.
450	Vertical Drill	36-in.	Bertram	3 A.C.
451	Small Punch and Shears			30 A.C.

Hydraulic Machines.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
476	Steam Pressure Pump	Duplex 4 in. x 18 in. plungers	Snow Pump Works.	
477	Accumulator	1,500 lbs. per inch	R. D. Wood & Co.	
478	Gap Riveter	17 feet	R. D. Wood & Co.	
479	Crane Cylinder for 478		R. D. Wood & Co.	
480	Portable Gap Riveter	6 feet	Bement Miles.	
481	Mud Ring Riveter		Fielding & Platt.	
482	Punch and Shears		Fielding & Platt.	
483	Sectional Flanger		Bement Miles.	
484	Press for Small Work			
485	Punch and Shears		Fielding & Platt.	
486	Multiple Punch		Bement Miles.	
487	Tank Riveter		Fielding & Platt.	
488	Mud Ring Riveter		Bement Miles.	

BOLT DEPARTMENT.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
361	Turret Lathe	2 in.x26 in.	Pratt & Whitney.	
362	Turret Lathe	2 in.x24 in.	Jones & Lamson.	
363	Turret Lathe	2 in.x24 in.	Jones & Lamson.	
364	Hacksaw			20 A.C.
365	Oil Separator		Niles-B.-Pond	
366	Bolt Lathe			
367	Turret Lathe	2 in.x26 in.	Jones & Lamson.	
368	Turret Lathe	1½ in.x18 in.	Pratt & Whitney.	
369	Bolt Cutter	3-Spindle	Acme	
370	Bolt Lathe		Can. Pac. Ry.	
371	Bolt Lathe		Can. Pac. Ry.	
372	Bolt Lathe		J. H. Johnston	
373	Bolt Lathe		J. H. Johnston	
374	Bolt Lathe		J. H. Johnston	
375	Bolt Lathe		J. H. Johnston	20 A.C.
376	Centering Machine		D. E. Whiton	
377	Centering Machine		Pratt & Whitney.	
378	Bolt Lathe			
379	Bolt Lathe			
380	Stud Lathe		Smith & Coventry	
381	Nut Facer	¾-in. Nuts	Smith & Coventry	
382	Nut Facer	1½-in. Nuts	Smith & Coventry	

TIN SHOP.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
401	Emery Wheel	12-in. wheel	Niles-B.-Pond	
402	Press		Niagara Tool Co.	
403	Sheet Iron Shears	63 in. wide	Niagara Tool Co.	10 A.C.
404	Punch	No. 122	Niagara Tool Co.	
405	Circular Shears		Brown, Boggs&Co.	
406	Bending Rolls	5 in.x72 in.	Scully Steel Co.	

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The light parts, such as rods and motion work, are distributed in a rod department of about four bents, where this work is done within a radius of about 50 ft. The motion shop occupies about 10 bents, with cross benches and machines on both sides. One of the photographs shows these cross benches. All the benches are on the open floor, none of them being under the gallery. The driver brake, air pump and electric headlight work is provided for in the spaces beyond the motion department. The work benches are very substantial, consisting of 3-in. plank bolted to substantial cast iron supports, the supports being braced with ⅝-in. rods and held to the floor by lag screws. Each bench has two drawers, with substantial cast iron slides, which, when lubricated with graphite, work as easily as if they were on roller bearings. The top of the bench is of oak and the drawers of yellow pine. Each bench has also a yellow pine shelf below. They are sufficiently strong for heavy work. In the machine shop the benches are all out in the open. Wherever wall benches are used the construction is as shown in the engraving, which illustrates the bench used in the roundhouses of this road.

As far as possible material in this shop is kept off the floor. For holding the side and main rods of locomotives special tracks are provided in the erecting and machine shop. These are built with cast iron sections, very strongly braced, pro-

tions. In the lower portion of the engraving are the three longitudinal tracks extending through the shop, which are located at 25-ft. centers, which is an unusual distance between tracks. This necessitates an erecting shop bay with a crane span of 76 ft. 3 ins. Between the pit tracks are two standard gauge supply tracks. In the plan the lower, or southern, track has a pit 762 ft. long. The center track has a pit 894 ft. long, and the upper track a short pit 454 ft. long, making a total pit length of 2,110 ft. For convenience in getting about the engines the standing space in the erecting shop is limited to about 36 engines, although this number is somewhat elastic. The building is lighted by high windows and by long transverse skylights over its central portion. The roof trusses and crane supports are illustrated in the sectional view. For protection against fire the entire building is equipped with automatic sprinklers, and galvanized iron fire curtains are built in the roof trusses down to a point which will clear the cranes. These are placed at every seventh roof truss.

millers and the truck wheel and axle box work. A bracket jib crane of 1,500 lbs. capacity, with a pneumatic cylinder, serves the axle work. Two 1,000-lb. pneumatic cylinder bracket cranes handle work to the millers, and planers and truck wheel tires. A 1,000-lb. pneumatic jib crane serves the axle box work, and a 4-ton pneumatic cylinder hand travelling crane is located over the lye cleaning tank. Special care was taken to plan the shop for convenience in handling material, which is a matter of great importance in a plant of this size.

By referring to the floor plan, the departments beginning at the east end of the machine floor are as follows: The wheel shop, including the tire setting, driving box work, truck shop, cylinder shop, piston cross-head department, opposite which is the frame shop; the next space is for side rods, and beyond this motion work. Next comes spaces for miscellaneous departments, such as air pumps, pipe shop, track and spring shop, scale repair shop, some of the latter departments being in the west machine shop. West of this is the boiler shop, providing for flue work and general boiler work, including

INTERIOR OF MACHINE SHOP, SHOWING TRANSVERSE BENCHES AND ROD RACKS.

ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

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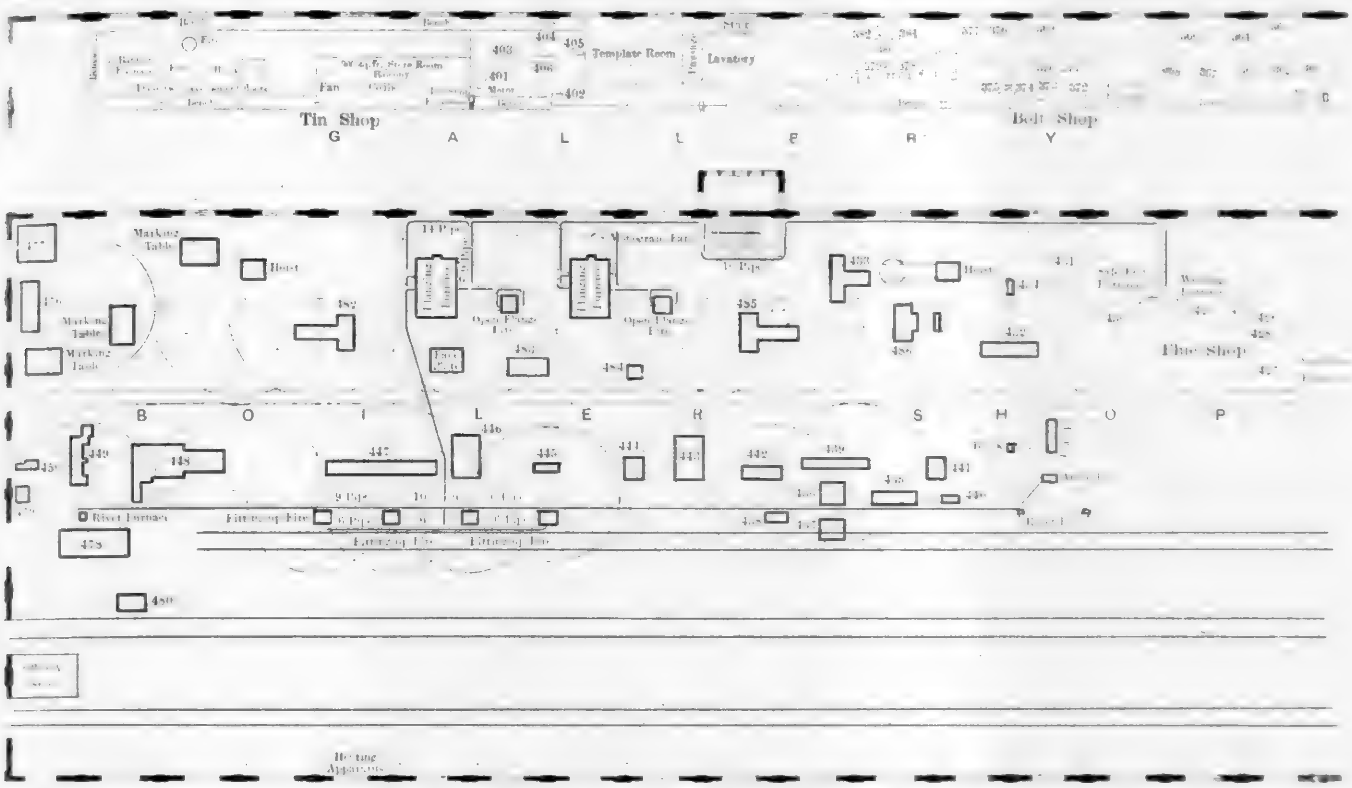

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ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

BOILER SHOP.

Power Machines.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
[illegible]	Swedging Hammer		Can. Pac. Ry.	Com. Air.
[illegible]	Tube Cutter		Can. Pac. Ry.	
[illegible]	Welding Machine		Hartz	15 A.C.
[illegible]	Welding Machine		Hartz	
[illegible]	Tube Cutter		Can. Pac. Ry.	
	Tube Cleaner		Whiting Fdry. Co.	20 A.C.
	Punch and Shears	Size "D"	Long & Allstatter	15 A.C.
[illegible]	Punch and Shears		Bertram	10 A.C.
[illegible]	Rotary Shears	¼ in. plate	Collier Co.	5 A.C.
[illegible]	Double Drill		Bertram	
[illegible]	Double Bolt Cutter	Acme 1½-in.	Bertram	
437	Triple Bolt Cutter	Acme 1½-in.	Bertram	
[illegible]	Vertical Drill	36-in.	Bertram	20 A.C.
[illegible]	Plate Planer	18-ft.	Craven Bros.	
[illegible]	Vertical Drill	24-in.	Smith & Coventry	
441	Mud Ring Drill	4 Spindles	Craven Bros.	
442	Small Plate Rolls	8 in.x7 ft.	Craven Bros.	
443	Flue Sheet Drill	2 Spindles	Bertram	7.5 A.C.
444	Flue Sheet Drill	2 Spindles	Craven Bros.	
445	Horizontal Punch		Berry & Co.	7.5 A.C.
[illegible]	Flue Sheet Drill	3 Spindles	Bertram	5 A.C.
447	Plate Planer	25-ft.	Bertram	15 A.C.
448	Large Plate Roll	16 in.x12 ft.	Bertram	30 A.C.
449	Mud Ring Drill	6 Spindles	Bement Miles	7.5 A.C.
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477	Accumulator	1,500 lbs. per inch	R. D. Wood & Co.	
478	Gap Riveter	17 feet	R. D. Wood & Co.	
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480	Portable Gap Riveter	6 feet	Bement Miles.	
481	Mud Ring Riveter		Fielding & Platt.	
482	Punch and Shears		Fielding & Platt	
483	Sectional Flanger		Bement Miles	
484	Press for Small Work			
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361	Turret Lathe	2 in.x26 in.	Pratt & Whitney	
362	Turret Lathe	2 in.x24 in.	Jones & Lamson.	
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364	Hacksaw			20 A.C.
365	Oil Separator		Niles-B.-Pond.	
366	Bolt Lathe			
367	Turret Lathe	2 in.x26 in.	Jones & Lamson.	
368	Turret Lathe	1½ in.x18 in.	Pratt & Whitney.	
369	Bolt Cutter	3-Spindle	Acme	
370	Bolt Lathe		Can. Pac. Ry	
371	Bolt Lathe		Can. Pac. Ry.	
372	Bolt Lathe		J. H. Johnston	
373	Bolt Lathe		J. H. Johnston	
374	Bolt Lathe		J. H. Johnston	
375	Bolt Lathe		J. H. Johnston	20 A.C.
376	Centering Machine		D. E. Whiton	
377	Centering Machine		Pratt & Whitney.	
378	Bolt Lathe			
379	Bolt Lathe			
380	Stud Lathe		Smith & Coventry	
381	Nut Facer	¾ in. Nuts	Smith & Coventry	
382	Nut Facer	1½-in. Nuts	Smith & Coventry	
	TIN SHOP.			
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402	Press		Niagara Tool Co.	
403	Sheet Iron Shears	63 in. wide	Niagara Tool Co.	10 A.C.
404	Punch	No. 122	Niagara Tool Co.	
405	Circular Shears		Brown, Boggs&Co.	
406	Bending Rolls	5 in.x72 in.	Scully Steel Co.	

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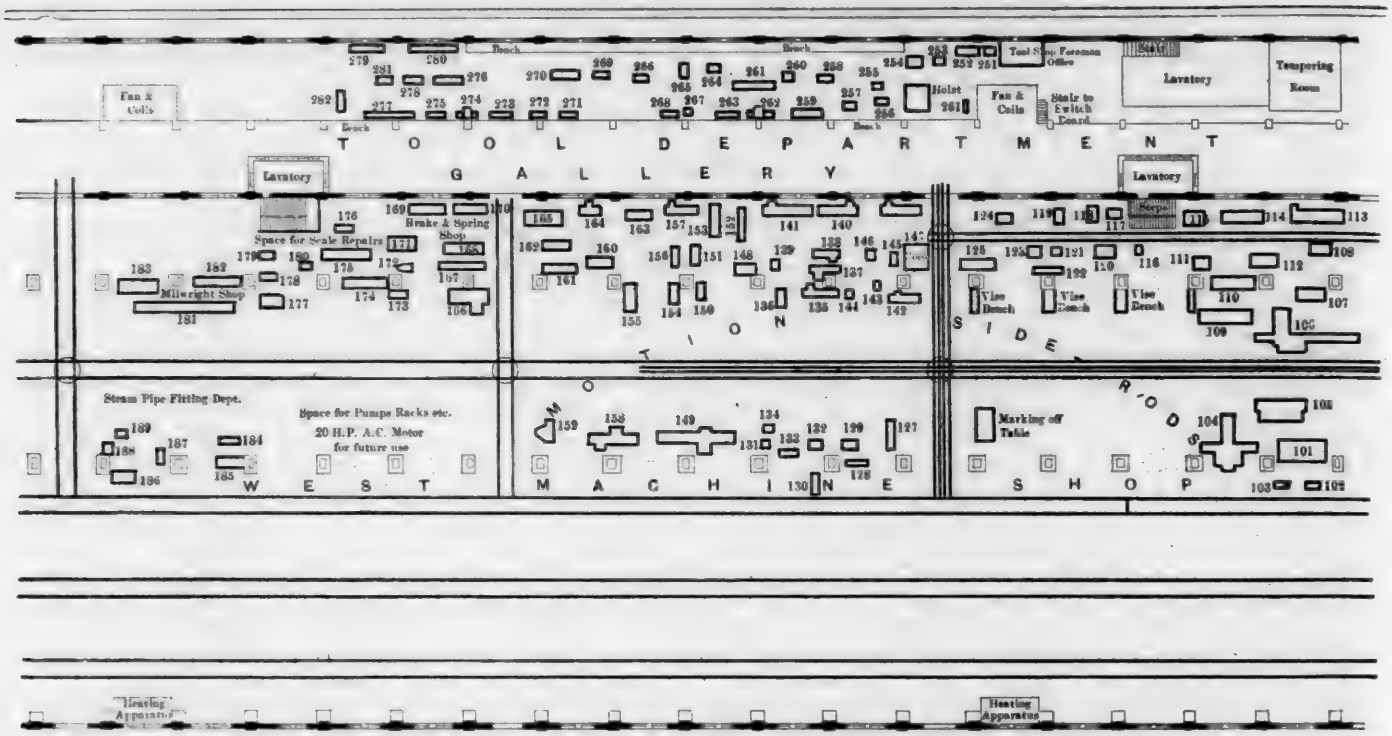


PLAN OF WEST END OF MACHINE SHOP, ALSO SHOWING GALLERY AND ERECTING SHOP.

ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

WEST MACHINE SHOP.

Side Rod Department.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
101	Side Rod Drill	3 Spindles	Bertram	
102	Vertical Drill	36-in.	Bertram	20 A.C.
103	Vertical Drill	24-in.		
104	Miller	5 ft.x5 ft.x12 ft.	Ingersoll	
105	Side Rod Shaper	24-in.—2 heads	Bertram	2-5 A.C.
106	Double Planer	4 ft.x4 ft.x14 ft.	Pond	15 A.C. 2–2 A.C.
107	Turret Lathe	5-in.	Bardons & Oliver	
108	Vertical Drill	40-in.	Bement Miles	
109	Double Slotter	12-in. stroke	Bertram	20 A.C.
110	Double Drill		Craven Bros.	
111	Vertical Drill	36-in.	Craven Bros.	
112	Slotter	16-in.	Bertram	
113	Double Planer			
114	Cotter Mill	4-Spindle		10 A.C.
115	Vertical Drill	40-in.	Bement Miles	
116	Vertical Drill	24-in.		
117	Shaper	12-in.		
118	Shaper	24-in.	Bertram	
119	Crank Planer	18 in.x18 in.x18 in.	Bertram	
120	Chucking Lathe	24-in.	Craven Bros.	
121	Chucking Lathe	20-in.	Craven Bros.	20 A.C.
122	Engine Lathe	16 in.x5 ft. 6 in.	Gardner	
123	Chucking Lathe	24-in.	Craven Bros.	
124	Turret Boring Mill	30-in.	Niles	
125	Engine Lathe	20 in.x5 ft.	McGregor	
126	Suspended Emery Wheel	20-in.	Bridgeport Co.	

Motion Department.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
127	Side Bar Grinder		Bertram	
128	Engine Lathe	12 in.x2 ft. 6 in.	Smith & Coventry	
129	Link Grinder	5-ft. radius	Smith & Coventry	
130	Grindstone	6-ft.	Niles B. Pond	20 A.C.
131	Double Buffer	30 in.x8 in.	Niles B. Pond	
132	Emery Grinder	20-in. wheel	Can. Pac. Ry.	
133	Lapping Lathe			
134	Grinder	Lea No. 1	Anderson T. Co.	2 small D.C.
135	Engine Lathe	24 in.x5 ft. 4 in.	M'Greg. & Gourlay	
136	Shaper	24-in.	Flather	
137	Engine Lathe	18 in.x5 ft.	Bertram	
138	Engine Lathe	16 in.x5 ft.	Gardner	
139	Shaper	4-in.		
140	Engine Lathe	24 in.x6 ft.	Bertram	
141	Engine Lathe	30 ins.x8 ft. 6 in.	Bertram	
142	Engine Lathe	18 in.x3 ft. 6 in.	LeBlond	20 A.C.
143	Vertical Drill	20-in.	Craven Bros.	
144	Vertical Drill	20-in.	Craven Bros.	
145	Shaper	16-in.	Bertram	
146	Centering Machine		D. E. Whiton	
147	Engine Lathe	22 in.x8 ft. 6 in.		
148	Vertical Drill	36-in.	Craven Bros.	
149	Planer	4 ft.x4 ft.x12 ft.	Flather	20 A.C.
150	Vertical Drill	24-in.	Craven Bros.	
151	Vertical Drill	36-in.	Craven Bros.	
152	Planer	2 ft.x2 ft.x6 ft.	Bertram	
153	Planer	2 ft.x2 ft.x4 ft.	Craven Bros.	15 A.C.
154	Vertical Drill	36-in.	Bertram	
155	Slotter	16-in.	Bertram	
156	Vertical Drill	36-in.	Bertram	
157	Engine Lathe	24 in.x5 ft. 6 in.	Gardner	
158	Extension Lathe	36 in.x72 in.x10 ft.	Bertram	10 A.C.
159	Boring Mill	51-in.	Niles	

Mach. No.	Name.	Size.	Maker.	Motors H. P. & Type.
160	Double Shaper	6-in.	Craven Bros.	
161	Turret Lathe	3 in.x36 in.	Pratt & Whitney	
162	Turret Lathe	2in.x24 in.	A. Hebert	15 A.C.
163	Horz. Boring Mill	3-in. bar	Bement Miles	
164	Cutting-Off Mach.	5-in.	Bertram	
165	Horz. Boring Mach.		Craven Bros.	

Brake, Spring and Manufacturing Department.

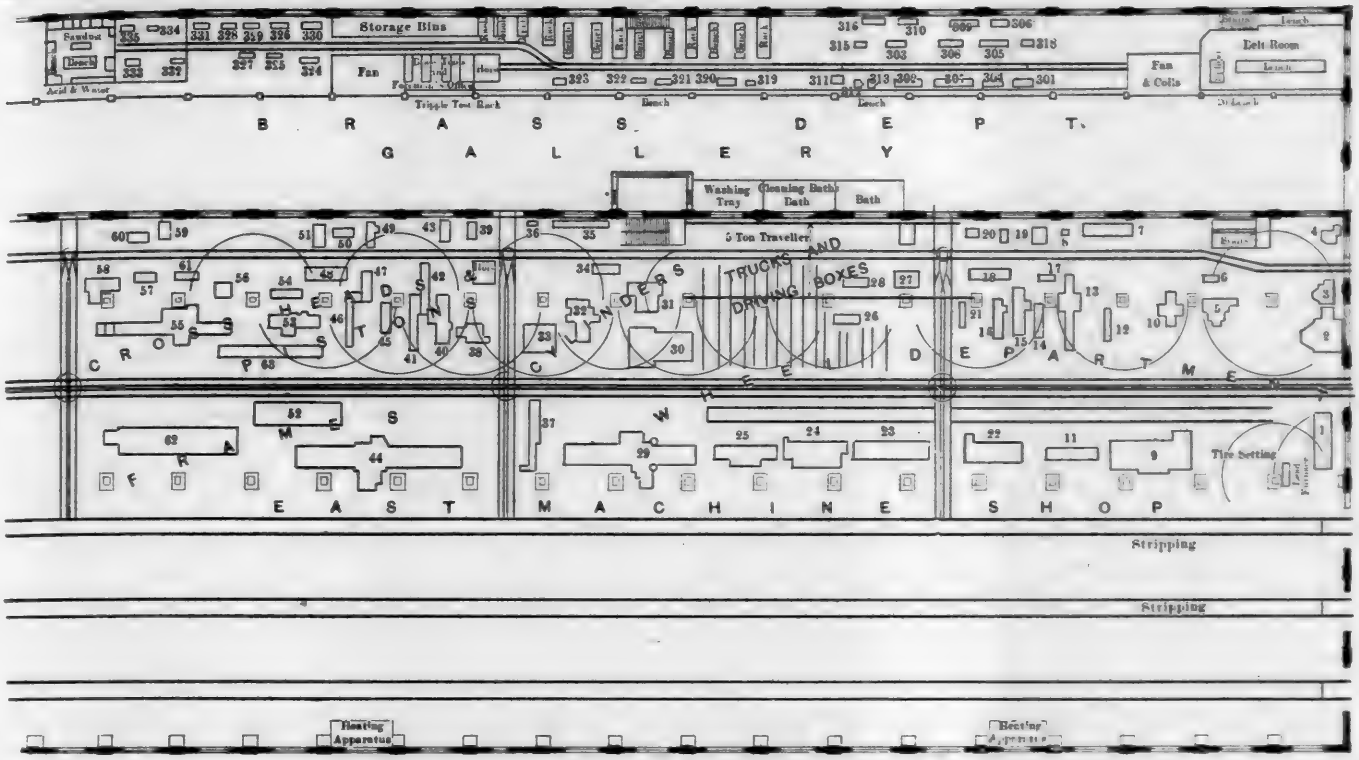
Mach. No.	Name.	Size.	Maker.	Motors H. P. & Type.
166	Radial Drill	5-ft.	Hulse & Co.	
167	Engine Lathe	24 in.x8 ft.	Bertram	
168	Double Shaper	14-in.		10 A.C.
169	Engine Lathe	20 in.x5 ft.		
170	Engine Lathe	30 in.x6 ft.	Bertram	
171	Vertical Drill	45-in.	Bertram	
172	Vertical Drill	36-in.	Bertram	
173	Vertical Drill	36-in.	Bertram	
174	Double Drill		Bertram	
175	Screwing Machine	3-in.	Smith & Beacock	
176	4 Spindle Drill	Up to ½ in.	Foote Burt	10 A.C.
177	Slotter	12-in.	W. Collier	
178	Slotter	10-in.	W. Collier	
179	Slotter	10-in.	W. Collier	
180	Emery Grinder	20-in. wheel	Can. Pac. Ry.	
181	Engine Lathe	24 in.x22 ft.	Bertram	
182	Engine Lathe	24 in.x9 ft.	Smith & Coventry	15 A.C.
183	Horz. Boring Mach.	4 in.x9 ft.	Bertram	

Steam Fitting and Air Brake Department.

Mach. No.	Name.	Size.	Maker.	Motors H. P. & Type.
184	Engine Lathe	18 in.x3 ft. 6 in.	LeBlond	
185	Vertical Drill	36-in.	Bertram	
186	Pipe Threader	10-in.	Cox & Sons	15 A.C.
187	Pipe Threader	4-in.	Williams Tool Co	
188	Pipe Threader	4-in.	Armstrong	
189	Emery Wheel	12-in.	Can. Pac. Ry.	
190	Face Grinder		Iroquois Wheel Co.	15 A.C.
191	Drill Grinder	Yankee	Wilmarth&Morman	

Tool Department.

Mach. No.	Name.	Size.	Maker.	Motors H. P. & Type.
251	Emery Grinder	20-in. wheel	Can. Pac. Ry.	
252	Emery Grinder	20-in. wheel	Can. Pac. Ry.	
253	Tool Grinder	No. 2	Sellers	
254	Tool Grinder	No. 1	Sellers	
255	Drill Grinder		Sellers	
256	Tool Grinder		Cincinnati	
257	Universal Miller		LeBlond	
258	Vertical Drill	30-in.	Bertram	
259	Universal Grinder	No. 7	Landis	20 A.C.
260	Plain Miller		Bertram	
261	Engine Lathe	22 in.x3 ft. 6 in.	LeBlond	
262	Engine Lathe	20 in.x4 ft. 6 in.	LeBlond	
263	Engine Lathe	14 in.x2 ft. 8 in.	Pratt & Whitney	
264	Disc. Grinder	No. 1	Chas. Besly	
265	Shaper	24-in.	Flather	
266	Vertical Drill	30-in.	Bertram	
267	Tool Grinder	6-in. wheel		
268	Double Shaper	4-in.	Craven Bros.	
269	Universal Miller	No. 3	Cincinnati	
270	Turret Lathe	2 in.x24 in.	Jones & Lamson	
271	Engine Lathe	16 in.x3 ft.	Gardner	
272	Engine Lathe	14 in.x3 ft.	Smith & Coventry	
273	Engine Lathe	16 in.x2 ft.		
274	Engine Lathe	16 in.x3 ft.	Gardner	
275	Engine Lathe	16 in.x3 ft.	Brown & Sharpe	20 A.C.
276	Engine Lathe	16 in.x4 ft. 6 in.	Smith & Coventry	
277	Engine Lathe	24 in.x10 ft.	Bertram	
278	Engine Lathe	12 in.x3 ft.	Smith & Coventry	
279	Hack Saw		Patterson Tool Co.	
280	Engine Lathe	18 in.x9 ft.	LeBlond	
281	Engine Lathe	10 in.x3 ft.	Whitworth	
282	Wet Grinder	42-in. wheel	Bridgeport	



PLAN OF EAST END OF LOCOMOTIVE SHOP, SHOWING GALLERY AND ERECTING SHOP.

ANGUS SHOPS, CANADIAN PACIFIC RAILWAY, MONTREAL.

EAST MACHINE SHOP.

Wheel Department.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
1	Wheel Press	300 tons	Bertram	10 A.C.
2	Boring Mill	90-in.	Niles	20 D.C. 2-5 D.C.
3	Boring Mill	51-in.	Bullard	10 D.C.
4	Boring Mill	51-in.	Niles	7.5 D.C.
5	Boring Mill	64-in.	Bertram	
6	Car Wheel Borer			
7	Engine Lathe	30 in.x4 ft.	Pond	15 A.C.
8	Emery Wheel	20-in. wheels	Niles-Be't Pond	
9	Wheel Lathe	90-in.	Niles	3 A.C. & 30 A.C.
10	Boring Mill	84-in.	Craven Bros.	15 A.C.
11	Quartering Machine	90-in.	Bertram	2-5 A.C.
12	Planer	4 ft.x4 ft.x12 ft.	Bertram	20 A.C.
13	Horz. Miller	42 in.x42 in.x14 ft.	Bement Miles	20 D.C.
14	Axle Lathe			
15	Axle Lathe	14 in.x8 ft.	Bertram	
16	Axle Lathe			
17	Shaper	24-in. stroke	Niles	
18	Planer	32 in.x32 in.x8 ft.	Craven Bros	30 A.C.
19	Shaper	14-in. stroke	Craven Bros	
20	Boring Mill	37-in.	Niles	
21	Radial Drill	4-ft.		
22	Wheel Lathe	72-in.	Bertram	
23	Wheel Lathe	84-in.	German Niles	30 A.C.
24	Wheel Lathe	84-in.		
25	Wheel Lathe	60-in.	Bertram	
26	Slotter	20-in. stroke	Bertram	
27	Vertical Drill	50-in.	Bement Miles	10 A.C.
28	Slotter	14-in.	Craven Bros	

Cylinder and Frame Department.

Mach. No.	Name.	Size.	Maker.	Motor. H. P. & Type.
29	Planer	6 ft.x6 ft.x22 ft.	Pond	30 A.C. 5 A.C.
30	Radial Drill	9-ft.	Bement Miles	5 A.C.
31	Radial Drill	6-ft.	Bertram	5 A.C.
32	Planer	5 ft.x5 ft.x8 ft.	Sharp, Stewart Co.	
33	Cylinder Borer		Craven Bros	
34	Slotter	14-in. stroke	Newton	30 A.C.
35	Engine Lathe	24 in.x5 ft.	Lodge & Shipley	
36	Slotter for valve bush	5-in. stroke	Can. Pac. Ry	
37	Cylinder Borer	8 bars	Bement Miles	10 D.C.
38	Boring Mill	60-in.	Niles	10 D.C.
39	Chucking Lathe	30-in.	Craven Bros	
40	Extension Lathe	36 in.x72 in.x10 ft.	Bertram	
41	Engine Lathe	36 in.x9 ft. 6 in.	Pond	20 A.C.
42	Engine Lathe	24 in.x7 ft. 6 in.	Bertram	
43	Chucking Lathe	30-in.	Craven Bros	
44	Planer, Frame	6 ft.x6 ft.x32 ft.	T. N. Shanks	20 A.C.
45	Chucking Lathe	36-in.	Craven Bros	
46	Engine Lathe	30 in.x10 ft.	Pond	
47	Engine Lathe	30 in.x6 ft.	Stewart	
48	Planer	32 in.x32 in.x8 ft.	Craven Bros	20 A.C.
49	Chucking Lathe	24 in.x4 ft.	Bertram	
50	Crank Planer	24 in.x24 in.x24 in.	Craven Bros	
51	Drill	36-in.	Craven Bros	
52	4-Spindle Drill	For Frames	Bement Miles	4-5 D.C
53	Extension Lathe	36 in.x72 in.x10 ft.	Bertram	
54	Horz. Boring Mill	4 in. bar x9 ft.	Binsse	
55	Planer	5 ft.x5 ft.x20 ft.	Bertram	
56	Vertical Miller	No. 6	Becker Brainard	30 A.C.
57	Emery Grinder	20-in. wheel	Niles-Be't Pond	
58	Radial Drill	5-ft.	Hulse & Co	
59	Shaper	24-in.	Flather	
60	Crank Planer	2 ft.x2 ft.x2 ft.	Craven Bros	10 A.C.
61	Cotter Drill	No. 3	Bement Miles	
62	Triple Slotter	24-in. stroke	Bertram	20 A.C.
63	Triple Slotter	8-in. stroke		10 A.C.

Brass Department.

Mach. No.	Name.	Size.	Maker.	Motors H. P. & Type.
301	Engine Lathe	12 in.x3 ft. 9 in.	Bertram	
302	Turret Lathe	24-in.	Am. Tool Co	
303	Forming Lathe	18-in.	Warner & Swasey	
304	Engine Lathe	20 in.x2 ft. 6 in.	Bertram	
305	Turret Lathe	24-in.	Smith & Coventry	
306	Turret Lathe	14-in.	Bertram	
307	Engine Lathe	24 in.x4 ft. 8 in.	LeBlond	
308	Turret Lathe	20-in.	Bertram	
309	Turret Lathe	22-in.	Bullard	
310	Turret Lathe	20-in.	Warner & Swasey	20 A.C.
311	Valve Miller	2 Spindles	Warner & Swasey	
312	Chucking Lathe	15-in.	Smith & Coventry	
313	Chucking Lathe	15-in.	Smith & Coventry	
314	Turret Lathe	16-in.	Smith & Coventry	
315	Turret Lathe	16-in.	Warner & Swasey	
316	Turret Lathe	16-in.	Smith & Coventry	
317	Emery Grinder	6-in. wheel	Can. Pac. Ry	
318	Saw		Can. Pac. Ry	
319	Valve Grinder		Warner & Swasey	
320	Vertical Drill	30-in.	Bertram	
321	Forming Lathe	16-in.	Warner & Swasey	10 A.C.
322	Turret Lathe	1 in.x10 in.	Pratt & Whitney	
323	Disc. Grinder	No. 4	Charles Besly	
324	Sensitive Drill		Can. Pac. Ry	
325	Speed Lathe	13-in.	Am. Tool Co	
326	Turret Lathe	16-in.	Warner & Swasey	
327	Speed Lathe	13-in.	Am. Tool Co	10 A.C.
328	Turret Lathe	16-in.	Smith & Coventry	
329	Turret Lathe	16-in.	Niles-B.-Pond	
330	4-Spindle Drill	To ½ in.	Foote Burt	
331	Turning Lathe	14-in.	Am. Tool Co	
332	Buffer		Can. Pac. Ry	
333	Buffer		Can. Pac. Ry	
334	Buffer		Tacker Levett	20 A.C.
335	Buffer		Dickerman	

viding shelves for small material, and strong cast iron brackets for holding the rods themselves. From these brackets the rods are easily raised by the cranes. The drawing shows a cross-section, indicating the use of angles as braces, and showing the shelves, which are of 1-in. lumber. The benches are similar to those used at the Collinwood shops of the L. S. & M. S. Ry., and they were also used at the McKees Rocks shops of the P. & L. E. Ry.

This plan provides for heavy and light repairs of about 50 engines per month, and in addition to this about six new engines are built per month, which renders the matter of transporting material an exceedingly important one. The tonnage of material handled per month will approximate 600 tons. The average space provided per machine in the main machine shop, including the track area and truck shop, is

520 sq. ft. per machine. Omitting the truck shop and the through track area, but including the wheel storage space, 376 sq. ft. per machine was provided. The total area of the wheel storage tracks amounts to 1,805 sq. ft.; deducting this space, the actual floor area for each machine is 316 sq. ft.

The east end of the locomotive shop is near the store house, the blacksmith shop and the midway crane. All new material, except tires and boiler plate, comes to the shop at the east end. The tires are stored on a platform outside of the shop, and boiler material is stored out of doors at the west end of the shop. The new material is received under the cranes, and may be taken to any point in the building by cranes or trucks. The repair material is distributed from the stripping pit or the lye vats. The machinery was arranged to conserve as nearly as possible a systematic movement, keeping in view the importance of utilizing all of the space and keeping all of the heavy work under cranes and putting the light work under the gallery. The tool arrangement was influenced considerably by the group system of driving, and also by the necessity for mixing the work of manufacturing and repairs in the same plant.

Space will not permit of a complete description of the machine arrangement, but a glance at the plan will show the clear avenues for material which are maintained the whole length of the building. An example of the excellent arrangement of a group of machines is that of the wheel department, which is provided with its own cranes and is made independent of all the travelling cranes. The machinery of this department was located so as to minimize the distance of movement, and at the same time to provide sufficient space around the machines.

The boiler shop provides for tank and cab work, and the tube department. Tubes are rattled in a chain rattler, built from the design of Mr. G. R. Henderson, illustrated in this journal in June, 1904, page 220. This machine receives the tubes on a small car, picks up a complete set of tubes from the car, rattles them and loads them upon the car again. To unload the rattler and load it up again with another set of tubes ready for work requires six minutes. One of these rattlers is working very satisfactorily in the Topeka shops of the Atchison, Topeka & Santa Fe Railroad. The chains run at a speed of 115 ft. per minute, driven by a 20-h.p. motor.

The furnaces in the locomotive shop are of the Ferguson make, using oil fuel. The tube department is conveniently arranged, but is likely to be improved, with a view of reducing the cost of this work.

Electrical distribution begins at a large distributing board over the machine shop and east of the center of the building. The machine cables run down the columns in pipes and across to the machines under the floor. The alternating current motors are provided with compensators for starting, giving a large torque in order to start the machines under load. In a few cases the machines are equipped with ordinary switches. All of the controllers are of the Canadian General Electric Company's manufacture. The direct current motors have Canadian General Electric controllers for field control; their range in speed is 2 to 1, except one Milwaukee and one Westinghouse motor in the wheel department, having respectively a 4 to 1 and 2 to 1 variation.

In this magnificent shop a slightly increased expenditure would have been advantageous in increasing the proportion of variable speed driving. It would be easily possible to secure at least 10 per cent. increased output of many of the machines through more individual driving. In this entire shop there are but 9 variable speed D. C. motors applied to individual machines. This subject will be referred to again.

The output, organization and a description of the principle machine tools will be presented in the next installment. We are especially indebted to Mr. H. H. Vaughan, Mr. W. F. Connal and Mr. J. H. Morton for information connected with this description.

Mr. F. A. Delano has been elected vice-president of the Wabash system.

REPORT OF COMMITTEE ON POWER.

ROCK ISLAND COMPANY.

(For previous article see page 121.)

SUPERHEATING.

In the last three or four years considerable progress has been made abroad in the use of superheated steam for locomotives The Germans have made the greatest advances in this direction, and at the present time have some fifty or more locomotives equipped with superheaters. The first two engines equipped with the Schmidt system were put into service in 1898 on the Prussian State Railways. These engines are still running, and after various modifications are reported as now giving satisfaction, and are to-day considered among the best of the engines for passenger service, in spite of the fact that they are in various respects not up to date in construction.

The present practice in Germany is to apply mostly the Schmidt system, but the Pielock is also used to a limited extent. The original Schmidt system consists briefly of a large flue in the lower part of the boiler with the superheater pipes located in the smokebox. In the later Schmidt design a number of 5-in. flues are located in the upper part of the boiler and the superheater pipes arranged inside these flues in groups of four. The Pielock design consists of a superheating chamber located in the barrel of the boiler, the boiler tubes passing through the chamber and expanded and set in the ends of the superheating chamber, as well as in the front and in the back flue sheets.

Some difficulty in American practice will probably be experienced with this form of superheater. The removal of the flues when heavily coated with scale may be attended with considerable difficulty and be a slow process. The expanding of the flues in the superheater chamber and the location of leaks into the chamber are difficulties which must be considered and met.

The advantages of superheated steam were very early recognized in the development of the steam engine, and numerous designs were made and in some cases patents obtained as far back as forty or fifty years ago. The use of superheaters in early days was very much handicapped by the use of vegetable and animal oils and inferior tubes. With the introduction of mineral oils of high fire test, which would not disintegrate at high temperature, and solid drawn seamless tubes, the way was opened for the successful use of superheaters.

Of the tests which have been made in Germany and for the last three years in this country, the facts must be established that the valves and cylinders can be properly lubricated by the use of suitable appliances and with mineral oil of high fire test, and the superheater pipes made of seamless tubes do not corrode and wear out with undue rapidity, but that a life of several years can be obtained from them.

Three engines have been equipped with superheaters on the Canadian Pacific Railway, one in June, 1901, at their Montreal shops, with the earlier Schmidt system, consisting of a large flue in the bottom of the boiler and the superheater pipes in smokebox; two ten-wheel compounds, one of which was built in Glasgow in 1903, and one at the Schenectady Works of the American Locomotive Company. These were equipped with the latest form of Schmidt superheater, in which the tubes of the superheater were located in groups of four in 5-in. flues, located in the upper part of the boiler. The reports indicate that the performance of all these engines has been quite satisfactory, and that a substantial saving in coal and water has been effected. The fuel reports show that a large saving in fuel was made in a period of over three years of superheater over a simple engine, and about 10 per cent. to 15 per cent. on the superheated compounds over the compounds without the superheater. (Since then more than 40 superheaters have been applied on that road. See AMERICAN ENGINEER, December, 1904, page 456.)

Apart from the saving in fuel, one of the greatest advantages of superheating is the use of dry steam in cylinders, as

avoids many of the troubles due entirely to water, such as ...ken cylinders and heads, shocks and strains to piston rods, ..nk pins, crossheads, connecting rods, etc. It has been ..serted by competent authority that it is practically impos..le when running to carry water over into the cylinders, no ..tter how full the boiler may be. This alone is of great ..vantage, as a high water engineer can do no particular harm .. carrying several inches too much water. With foaming ..ter it would also appear to be of considerable value. It has ..en asserted by those who ought to know that, while the ..eatment of bad water decreases scaling very materially, the ..aming is increased, rendering it necessary in some parts of ..ew Mexico to run continually with the cylinder cocks open.

Superheating with piston valves is recommended, as the ..resence of water in cylinders of this type is liable to be much more detrimental than with slide valves. Furthermore, the ..alanced feature of the piston valve and probability of its more perfect lubrication are conditions which would make it appear desirable to use piston valves in connection with the superheater.

Saturated steam at 200 lbs. pressure has a temperature of 387 deg. Fahr. If superheated 175 deg. the temperature will be 562 deg., and it is obvious that 175 deg. of heat may be abstracted without decreasing the pressure. If, on the other hand, 175 deg. are taken from the saturated steam, the remaining temperature will be only 212 deg., or that of boiling water, and the pressure will consequently be zero. The thermo-dynamic efficiency of engines using superheated steam has never been questioned by engineers, and the advantages have been apparent for many years, but owing to failures which were met with many years ago, new experiments were usually discouraged on account of such failures. However, the experience in Germany has extended over six years in the use of superheated steam for locomotives, and it now appears that the earlier troubles have been largely overcome. It is reasonable to expect, however, that considerable changes in the method of application and design will be made in the next few years. There is no improvement in sight at the present time which offers so many advantages and so much economy, both in saving of fuel and water and the lessening of repairs, and from shocks and jars, due to presence of water in cylinders, as the application of superheaters. The experience in the last few years indicates very clearly that the additional complication to the boiler is comparatively slight, and that the superheater is not liable to require expensive repairs; nor has it been shown that failures in service may be expected.

The advantages of superheating were carefully considered by the American Locomotive Company, and a design was produced which seemed to be much simpler than any device hitherto prepared. In June, 1904, one engine of a lot of twenty for the New York Central was equipped at the Schenectady Works with a superheating device. (See AMERICAN ENGINEER September, 1904, page 338.) This engine went into passenger service, and has been running satisfactorily ever since. No trouble has ever been developed in the superheating arrangement, and only a slight difficulty was experienced in the lubricating device. The device applied to this engine seems to be much simpler and more straightforward than those designed abroad. The pipes require no bending, and can be removed in groups without disturbing the entire arrangement when repairs are necessary. The setting and adjustment is of the simplest possible nature, which can be readily done by the ordinary help in roundhouses. Orders have already been received for 26 of this type of superheater. (Many more have been ordered since this report was written.—EDITOR.)

In view of the promising results obtained from superheating, we recommend its application to a number of new locomotives, which will be required to take the place of the condemned engines, if the recommendations of the committee in regard to scrapping are carried out. As the conditions of service are so different on various parts of the Rock Island and 'Frisco systems, a test of only two or three locomotives might not be conclusive, and we would therefore recommend that a sufficient number be applied to get a thorough test under practical road conditions, incident to the Rock Island and 'Frisco systems.

BALANCED COMPOUND PASSENGER LOCOMOTIVES.

The characteristic and advantageous features of this type of engine, common to all builders, are as follows:

(a) Balancing of reciprocating parts by similar horizontal moving parts. One outside piston and its attachments moving forward while the inside one is moving backward. These balance one another without the use of unbalanced weights in the wheels.

(b) The increased weight permissible on the driving wheels when considered dynamically. In the ordinary engine, at 60 miles per hour, with drivers 78 ins. in diameter, the increase at each revolution at the static weights on the rail is about 23 per cent. This is due to the centrifugal effect of the excess weights used to balance the reciprocating parts.

(c) Increase of from 25 to 33 per cent. in sustained h.p. at moderate and high speeds without any material change in size or style of boiler.

(d) Economy in the use of fuel, water and steam.

(e) The advantages from light moving parts, such as cross heads, main rods, piston rods, etc. The lightness of these parts permits them to be easily handled and the probability is, as they only have to transmit one-half the usual amount of power, that the wear and repairs will be greatly decreased. The difference in the riding of these engines is very noticeable, running remarkably smoothly and easily at all speeds.

The greatest economy and refinement within the limits of good practice, as far as can now be seen, is the 4-cylinder balanced compound engine, equipped with superheater. As the additional weight of the superheater appliances is only about 2,000 lbs., there seems to be no practical difficulty in its application to an engine of this kind.

ELASTIC LIMIT OF AN AUDIENCE.

When an audience is tired out by the author of a paper who occupies too long a time in presenting his subject, the paper itself, if good, fails to receive the discussion which it merits, and the work of the organization suffers in many ways. Those in charge of meetings at which technical papers are presented would better serve the interests of individuals and the organizations if they would see that the speaker of the occasion appreciates the necessity of clear, definite and concise presentation. Many organizations in which our readers are interested provide in their by-laws for presentation of papers by abstract; but, how few observe the rule! It would be a real kindness to the author as well as the audience if the presiding officer would go to the speaker before the meeting and make sure that this is fully understood. Many good ideas fail to meet the reception they deserve because of a failure to appreciate the importance of the manner of presentation.

In an essay on "The Philosophy of Style" Herbert Spencer points out that "a reader or a listener has at each moment but a limited amount of mental power available," and therefore that it is important to economize his attention, because "the more time and attention it takes to receive and understand each sentence, the less time and attention can be given to the contained idea; and the less vividly will that idea be conceived." The purpose of any paper is always defeated when the audience is wearied by it. Preachers generally put up a silent petition before beginning their services, presumably for guidance in their ministration. It is suggested to the authors of technical papers that before they read them—or better still, before they are written—they offer up a petition somewhat to this effect: "From being a bore good Lord deliver me."

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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We cordially invite our many friends attending the conventions at Manhattan Beach in June to make use of our offices. Telegrams and mail addressed in our care will receive careful attention.

One of the large railroad systems made up of a number of roads of themselves large, finds itself saddled with over four hundred varieties of cars to operate and maintain. Nothing more than this need be said to indicate the necessity for standardization.

The proper application and care of belting adds much to the efficiency of a shop. A careful study of this subject as presented on another page of this issue will enable the average shop manager to not only decrease the cost of belt maintenance, but to considerably increase the output of the machines by reducing the time that they must lie idle while the belts are being repaired.

SHOP IMPROVEMENTS.

A young man recently appointed superintendent of shops of a large road called at the editorial rooms of this journal. He was touring about the shops of the leading roads and asked for suggestions as to promising places to visit. After visiting three shops, which are far in the lead in applying improvements which make for increased production and output, he called again on his way home. He was astonished by what he had seen and was greatly surprised to find how far in advance of his own work others were.

This superintendent was not discouraged, but his trip had given him a new view of his work and he was led to see the importance of shop methods as well as equipment. It is impossible for any one to take an extended trip about railroad shops without learning a lot from the practice of others, and this is specially true now when new machinery, improved tool steels, and piece work are changing shop methods so radically.

The experience of this man was interesting for two reasons. The greatest number of improvements were found in a few shops, and those were far in the lead of all the rest. The shops in which most was learned were well equipped with new tools, but the advanced practice was by no means confined to the work done by these tools. The whole plant seemed to be tuned up to a high speed. The shafting speeds were high and everything seemed to move on a "step-lively" plan. It was also quite noticeable that much of the noteworthy records for output were being made on tools which were very old, and this was done through a careful study of machine capacity and the development of jigs and chucks for reducing the time of setting work. The time required to set work up in the machine is sometimes many times greater than that of doing the machine work itself, and devices for aiding the setting up are equally effective in old and new machines. This emphasizes the importance of developing shop methods for handling work into the machines.

If a shop foreman cannot get all of the new machinery he needs, he can profitably turn his attention to systems of jigs and devices for holding work in the machines which he has, for the purpose of setting up quickly and taking the heaviest possible cut the machines can carry. He will then be ready for new and better machinery when he is allowed to order it. A man who can handle inadequate equipment effectively is prepared to handle a shop with good equipment.

LOCOMOTIVE STANDARDIZATION.

Elsewhere in this issue will be found the first of a series of articles presenting the common standards of the locomotives of the roads known as the Harriman lines. This is the most comprehensive plan of locomotive standardization ever effected. The possibilities, from the standpoint of economy, of reducing the number of different locomotive types on 18,000 miles of railroad to four need no emphasis. It is sufficient to point to the fact of six railroads using, for example, the same eccentrics and same driving boxes on all engines to indicate the advantages in shop operation and storehouse methods of such a scheme of standardization. This is specially important on these lines in view of the possibility of an interchange of locomotives among the roads, in accordance with varying traffic conditions. This comprehensive plan, together with the study of locomotive standards by the Rock Island Company, as outlined in this journal for March, 1905, page 84, indicate an unmistakable step towards unification of practice, which seems likely to constitute one of the greatest improvements of the day.

TEAM WORK LED BY THE PRESIDENT.

Recently in presenting a subject concerning the motive power department to a number of the highest railway officials the fact was developed that these gentlemen are surprisingly out of touch with the difficulties and problems of the heads of departments, where most of the direct administration responsibilities are carried. While there are exceptions, it may be confidently stated that the presidents of our railroads meet the heads of departments too infrequently to know the conditions of their problems. While anything resembling military despotism should have no place in the railroad organization it is evident that much might be gained if the presidents could occasionally meet the department heads for an occasional discussion of the results of operation. It may be said that presidents are too busy to do this. It is believed, however, that a great deal of time might be saved by holding an occasional council of war, which would tend to break down department lines and to induce all to direct their efforts to the common object. In these days of consolidation and concentration the higher officials need to guard against the tendency to drift away from the problem itself and from the individual officials who are closely in touch with it. If the president could meet the operating, mechanical, maintenance of way and purchasing officials several times a year for a fam-

y reunion, a great deal of time would be saved to all because of the better understanding of the common problem upon which they are working. The greatest of the manufacturing organizations have learned the value of such conferences.

How often do the department heads of railroads meet the president? The possibilities of the inspiration they would derive from a quarterly meeting of a couple of hours are impressive. The writer was privileged to attend such a meeting of one of the largest manufacturing organizations, in which the men who secure the results met the highest officials, and briefly, tersely stated the condition of their work. The president gave a ten-minute review of what he was trying to accomplish, followed by some direct questions to each department officer. All present felt the strength of the organization to do the next thing better than it was ever done before. Each officer felt the importance of his own part and that of each other officer. Departmental lines disappeared in the general lines of the policy concerning all. What a power would such a plan engender in a large railroad organization! What an inspiration would come from such team work! How much better would the motive power official feel toward his work if he could make himself understood by the president, the operating and the purchasing officials!

RAILROAD WORK FOR COLLEGE MEN.

There are no keener observers of the progress of railroad men than the students in college who are considering railroad work as a possible profession. Those who are in position to know, say that there is now a tendency among technical school students to avoid the courses in railroad subjects in favor of other lines.

The students, even if greatly attracted toward railroad work, are naturally discouraged from entering it when they see a well-equipped, experienced and successful officer at the head of the motive power department leave the service for an important position in an industrial concern, where he receives a salary double or treble that of the railroad position. They naturally turn toward lines of less resistance, and it is an important fact that it is becoming necessary to urge these young men toward the railroads, as their inclination is plainly in other directions.

This fact is important, and it should receive the attention of railroad managers, directors, and all others concerned with the future of railroads.

These young men should not be urged against their inclinations. The point is, that the railroads should make attractive their mechanical work, so that the right young men will enter it as recruits.

Motive power problems to-day present the most interesting, attractive and inspiring work lying before those who are mechanically inclined. There is only one view to take of the future, and that is optimistic. The work to be done surpasses in importance any movement toward improvement in any other line of human activity. To improve transportation by advancing the locomotive to a higher development is naturally attractive to the brightest minds. This development is many-sided, and offers worlds of commercial and administrative, as well as mechanical, problems to be conquered.

Railroad managements will soon come to appreciate the motive power department, as presenting the greatest problems and the greatest possibilities connected with operation. In time, the chief of the motive power department will be so thoroughly appreciated as to render it impossible for him to be enticed into any other line of service. This situation will not come of itself, and it will come the sooner because of losing many good motive power men. It would come at once if these men in a body should tire of present conditions and simultaneously step out. Because of the assurance that this department will be recognized, appreciated and provided for, a word to the students may now be said.

No one who knows the conditions expects a change to come in a day. It will come, however, by the time present students are prepared to become officials, and the millennium will come sooner and in more perfect condition if a lot of bright, earnest young men put their experience into the service. No college boy cares to play in, or, for that matter, even to watch, a football game when the score is 56 to 0. We all know how night is turned into day, however, after a game of 4 or 6 to 0. The railroad game is not easy, but it is sure to bring results to the right men.

The field is ready. The results are sure. The railroads cannot afford longer to delay making motive work attractive and possible to the brightest young men, and the men they need most, when these young men are deciding upon their course in life. On the other hand, the young men should be led to see the possibility of bringing about the desired conditions by entering and patiently putting their lives into this work.

50-TON COAL CARS IN FRANCE.

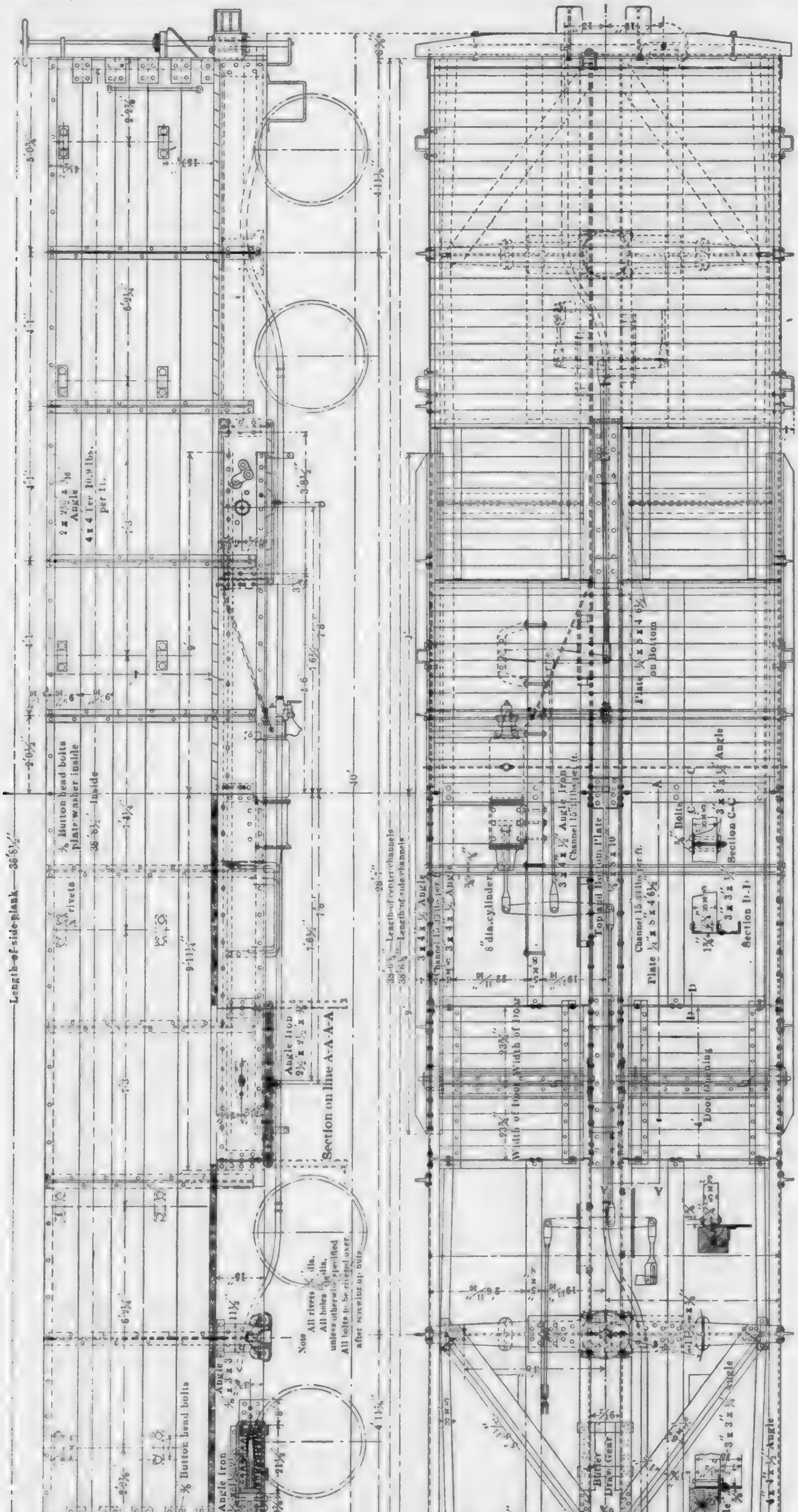
A movement has been started by the Southern Railway of France, in connection with the Carmaux coal mines and the Forges de Douai, to introduce 50-ton coal cars for coal and ore. These cars, which are illustrated and described in *Engineering*, are of the self-clearing hopper type, resembling the earlier forms of American cars of that form. These cars are 40 ft. 6 ins. long, and are carried on two 4-wheel Fox trucks. These cars have a cubic capacity of 2,048 cubic ft., and weigh 33,040 lbs. In addition to the hopper cars, the Southern Railway of France has introduced gondola cars for 50 tons of iron ore or 30 tons of coal. They have a capacity of 995 cu. ft., and weigh 33,936 lbs. The sides of these cars are of wood. The trucks have side frames resembling the Fox truck used in this country. These are joined together at the ends with cross members of pressed steel.

According to *Engineering*, "the test load, and which the bogie trucks are capable of carrying, has led the French companies to consider a reduction in the thickness of the steel plates, and to work in future for a ratio of 27 to 28 per cent. between the dead weight and the paying load. The Forges de Douai are contemplating a ratio of 25 per cent. when they are putting down presses for the manufacture of sills 65 ft. 7½ ins. in length." Such small ratios of dead to paying loads are worthy of special attention in American practice.

FIRE-PROOF CARS OF THE NEW YORK SUBWAY.

Destructive accidents seldom furnish such valuable information as a fire which occurred in the New York Subway March 29. In some way a train of five copper sheathed wooden cars (see AMERICAN ENGINEER, March, 1903) and two of the new steel cars (see AMERICAN ENGINEER, March, 1904) were set fire by collision with a bulkhead at the temporary end of the line. The heat drove everybody away and there were no fatalities or injuries. The fire after burning 24 hours, and consuming heavy timbering in the uncompleted end of the tunnel, burned itself out. The timbering of the tunnel was burned out and the five copper-sheathed wooden cars were entirely destroyed. The fire was hot enough to melt aluminum castings and fittings and to warp some of the plates, and yet the steel cars came through the fire in excellent condition.

Steel cars in the subway have also demonstrated their superior strength in a collision and together with the results of this fire the subway experience has thus far demonstrated the value of steel both for strength and for fireproof construction. The subway fire reproduced the conditions found in a furnace more nearly than those of a wrecked train burning in the open air. No stronger argument than this is necessary to direct attention to the very great advantages of steel in passenger car construction. It is to be hoped that the time is approaching when all new passenger cars will be built of steel.



100,000 LBS. STEEL UNDERFRAME DROP BOTTOM GONDOLA CAR—NORFOLK & WESTERN RAILWAY.

W. H. LEWIS, *Superintendent of Motive Power.*

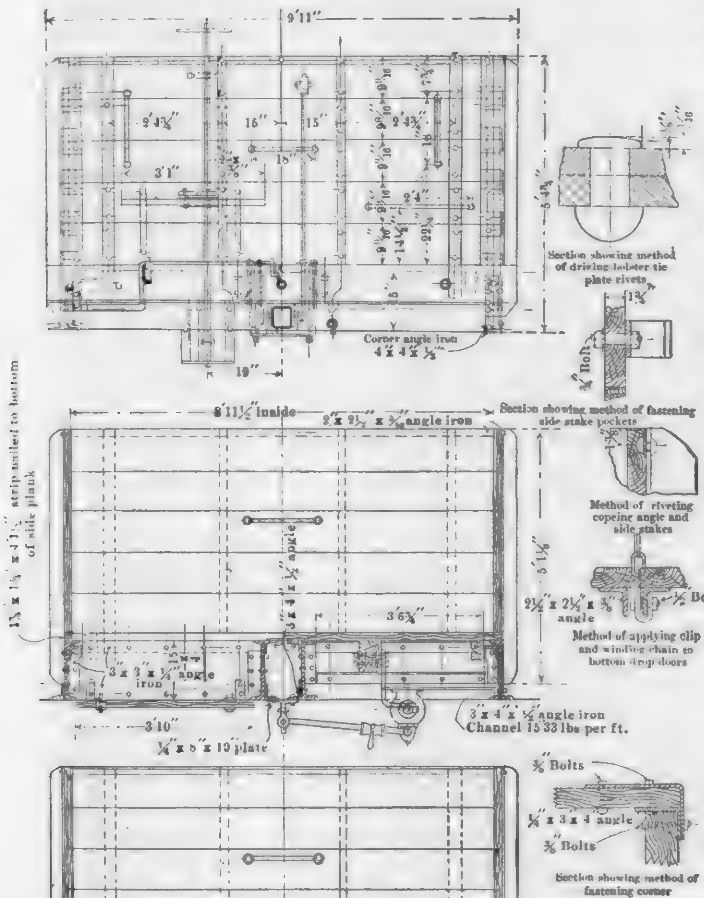
J. A. PILCHER, *Mechanical Engineer.*

STEEL UNDERFRAME DROP BOTTOM GONDOLA COAL CAR.

50 TONS CAPACITY.

NORFOLK & WESTERN RAILWAY.

In this journal in 1902, page 181, the 40-ton gondola coal car for this road, designated as class GG, was illustrated. In 1901, page 42, the 50-ton composite hopper coal car, class HG, was presented. The new design by Mr. John A. Pilcher, mechanical engineer of the road, is designated at class GI, illustrated herewith, is of 50 tons capacity with a steel underframe



CROSS-SECTIONS, NORFOLK & WESTERN GONDOLA CAR.

and relatively low (4-ft.) sides. The floor is flat with 4 drop doors. This new car differs materially from the designs of Mr. Seley previously mentioned. It has fixed ends and lower sides than the previous flat bottom gondolas. The new cars are intended for the shipment of lumber, and structural material, as well as coal. The following are the leading dimensions of class GI cars:

Length over end sills	40 ft. 0 ins.
Center to center of trucks	28 ft. 7 ins.
Length over body outside	38 ft. 8½ ins.
Length inside	38 ft. 2½ ins
Height of sides from under face of side sills	5 ft. 4¾ ins.
Depth inside	4 ft. 0 ins.
Width over all	9 ft. 11 ins.
Width over sides	9 ft. 3 ins.
Width inside	8 ft. 11½ ins.
Weight, empty	38,800 lbs.
Weight of two trucks	15,060 lbs.
Weight of steel work	29,100 lbs.
Cubical capacity	1,447 cubic ft.
Ratio dead to paying load	35.3 %

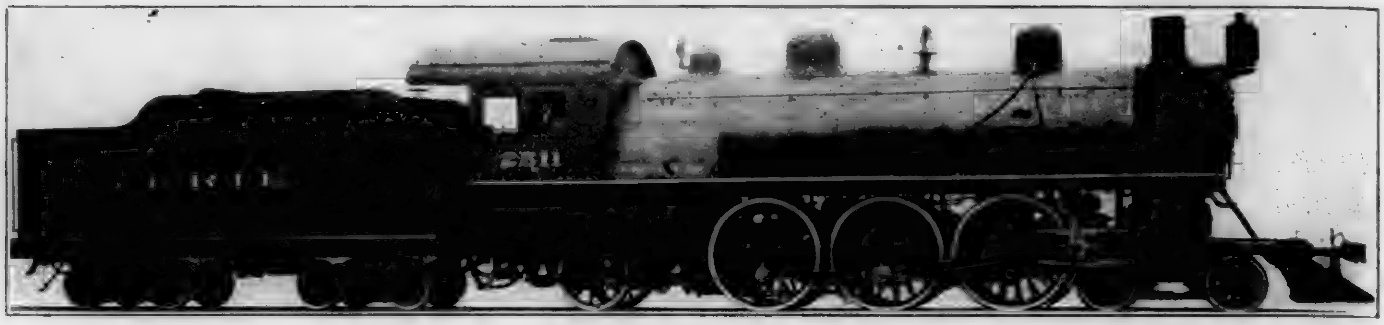
The new cars carry the load entirely by the underframe, in distinction to the two designs previously mentioned, which utilize the side frames as trusses. The center sills are of 15-in., 33-lb. channels, reinforced at the center of the car for a length of 18 ft. by 3 x 4 x ½-in. angles. These angles are riveted to the inside faces of the channels at the top and bottom, converting the channels into I beams at the central portion of the car. In addition to these angles the center sills have ¼ x 8 x 4 ft. 6 in. cover plates between the drop doors and 10 x 8-in. tie plates at the center of the car. The side sills are also 15-in., 33-lb. channels, reinforced with top and bottom 3 x 4 x ½-in. angles, through a distance of 18 ft. at the center of the car. The upper angles are inside of the channels and the lower angles outside, as shown in the sectional view. At the center of the car are diaphragms of plates and angles reaching from the center to the side sills. These are plate girders with two angles at the top and two at the bottom. At each door opening are plate diaphragms between the sills with single angles at the top and bottom. Between the drop doors and from the drop doors to the end sills 5 x 8 and 3 x 5 wooden floor stiffeners are employed, as shown in the plan. The doors are double, with openings 4 ft. x 3 ft. 7 ins. and closing against the lower faces of the side and center sills. The bolsters are of cast steel in two sections, riveted to the center and side sills, with pockets provided for the floor stiffeners to rest upon, as shown in one of the cross sectional views. Cover plates ⅝ x 11½ x 48 ins. are riveted to the tops of the bolsters and to the center sills. The ends of the bolsters have deep gussets, giving a substantial bearing for riveting to the side sills. The ends of the side sills are braced to the ends of the bolsters by ⅜ x 6-in. plates. The end sills proper are of ⅝ x 15-in. plates, carrying on their outer faces 5 x 3 x ½-in. angles, upon which the wooden end sills rest. The side stakes are 4 x 4-in. T's, 10.9 lbs. per ft.

This design embodies a very substantial underframe in a car weighing 38,800 lbs. The coal service on this road is very severe, as the cars frequently make 5,000 miles a month, running on the Norfolk & Western lines, chiefly between the mines and tidewater. That this road is using composite construction and steel underframes exclusively for new coal cars is an argument in favor of steel construction. The first car constructed from these drawings was loaded with 117,100 lbs. of coal, giving a deflection of 0.64 in. of the side sills and 0.76 in. of the center sills, measured at the center of the car. These figures confirmed the calculated deflections almost exactly. We are indebted to Mr. John A. Pilcher for the drawings.

OPEN-TOP OBSERVATION CARS.

The Denver & Rio Grande Railroad Company is now building a number of open-top observation cars to be attached during the summer months to daylight trains running through the Royal Gorge, Grand Canon of the Arkansas, Canon of the Grand River and the Black Canon of the Gunnison. These cars are of modern construction and have a seating capacity for seventy-two persons, low sides but no tops, being entirely open, thus giving a free and unobstructed view of the scenery of the Rocky Mountains. These cars will be completed and placed in service June 1 of the present year.

OWNERSHIP OF HOMES BY RAILROAD EMPLOYEES.—A scheme to encourage the ownership of land by the employees of the St. Louis, Browville & Mexico Railroad has just been put into effect, by which a land syndicate will sell five or ten acres of ground along the line of the road to employees at a fair price and on liberal terms. Water is supplied by the company and the families of the employees are protected. In case an employee is killed in the service, the land is to be deeded to his wife or family without further payment. In case an employee owning land leaves the service the land company will refund money paid upon the land and interest upon it at the same rate as he was charged for it. The plan seems to have excellent features, and it is hoped it will be an entire success.



PASSENGER LOCOMOTIVE WITH SUPERHEATER—ERIE RAILROAD.

4—6—2 (PACIFIC TYPE.)

In order to cope with trains of increasing weight the Erie Railroad has added to its locomotive equipment balanced compound locomotives, one of which is illustrated in this number, and also a very heavy and powerful 4—6—2 type locomotive with Cole superheater. The latter locomotive, recently completed at the Schenectady Works of the American Locomotive Company, has a total weight of 230,500 lbs. This engine has a tractive effort of 30,000 lbs. and a superheater of unusually large capacity, the heating surface of the superheater being 763.75 sq. ft., while the boiler heating surface is 3,321 sq. ft. It is, perhaps, hardly fair to add these two heating surfaces together, and say that the total heating surface is 4,084 sq. ft., but the figures added together give that amount, which is larger than has ever before been provided in a locomotive for passenger service, the largest boiler heating surface, without a superheater, for passenger service being that of the Pacific type locomotive of the Chicago & Alton, illustrated in March, 1903, page 87, which had 4,078 sq. ft. It is believed that the surface of the superheater is very much more effective in increasing the boiler capacity than the same amount of surface added to the boiler, therefore it may properly be stated that this is the most powerful boiler ever given to a passenger engine. The Erie Railroad has work for such an engine to do, and the performance records will be watched with the greatest interest. The superheater is of special interest, and will be illustrated next month. This boiler has 20-ft. tubes, which are only 1 ft. shorter than those of the Mallet compound of the Baltimore & Ohio, illustrated in June, 1904, page 237.

On April 24th engine No. 2512, which is exactly like the one illustrated except that it is not equipped with a superheater, made a remarkable run with a very heavy passenger train from Jersey City to Port Jervis. The data for this run are not yet completed, and will be referred to next month in connection with the description of the superheater of locomotive No. 2511.

The chief dimensions of the superheater locomotive are as follows:

4—6—2 PASSENGER LOCOMOTIVE—ERIE RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive power	30,000 lbs.
Weight in working order	230,500 lbs.
Weight on drivers	149,000 lbs.
Weight of engine and tender in working order	393,500 lbs.
Wheel base, driving	17 ft.
Wheel base, total	33 ft. 8 ins.
Wheel base, engine and tender	65 ft. 1 in.
RATIOS.	
Tractive weight ÷ tractive effort	4.9
Tractive effort x diam. drivers ÷ heating surface	669
Heating surface ÷ grate area	58.7
Total weight ÷ tractive effort	7.6
CYLINDERS.	
Kind	Simple.
Diameter and stroke	22½ by 26 ins.
Piston rod, diameter	3¾ ins.
VALVES.	
Kind	12-in. piston.
Greatest travel	6 ins.
Outside lap	1 in.
Inside clearance	⅛ in.
Lead in full gear	line and line.
Lead at ½ stroke	¼ in.
WHEELS	
Driving, diameter over tires	74 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	36 ins.
Engine truck, journals	6½ by 12 ins.
Trailing truck wheels, diameter	50 ins.
Trailing trucks, journals	8 by 14 ins.
BOILER.	
Style	Straight top.
Working pressure	200 lbs.
Outside diameter of first ring	74⅝ ins.
Firebox, length and width	108 by 75 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	195 2-in.; 32 5-in.
Tubes, gauge and length	No. 11, 20 ft.
Heating surface, tubes	3,119 sq. ft.
Heating surface, firebox	202 sq. ft.
Heating surface, total	3,321 sq. ft.
Superheater heating surface	763 sq. ft.
Grate area	56.5 sq. ft.
Exhaust pipe	Single.
Smokestock, diameter	18 ins.
Smokestack, height above rail	15 ft. 2¼ ins.
Centre of boiler above rail	113½ ins.
TENDER.	
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,500 gals.
Coal capacity	16 tons.

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At the twelfth annual convention, held in New Orleans April 11, this association gave its attention to a number of papers. The first, on oil cups and air strainers, by C. H. Larimer, directed attention to the necessity for improvement in the lubrication of air pumps, which is becoming more important with the increased duty expected of these pumps. As a necessary adjunct of the proper lubrication of the air cylinders, improved strainers with larger air inlets were advocated.

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a predetermined allowance of 1,500 lbs. unbraked weight per axle regardless of the weight of a car, this being preferable to an allowance of a certain percentage of the actual weight of the car to be left unbraked. He supported this argument by those recently made on an experimental train on the New York, Ontario and Western Railroad, in which the cars varied in weight from 46,000 to 103,000 lbs., the unusual variation being provided for by the proper use of 10, 12, 14 and 16-in. cylinders. Mr. Nellis raised the important question of basing the braking upon service instead of emergency application, believing that we should reverse the usual way and give primary attention to the service feature of the brake, because hundreds of service applications are made to one emergency application. Experiments referred to have shown that it is possible to entirely eliminate slid flat wheels in passenger equipment. He left the subject of similar treatment of freight braking to a future paper.

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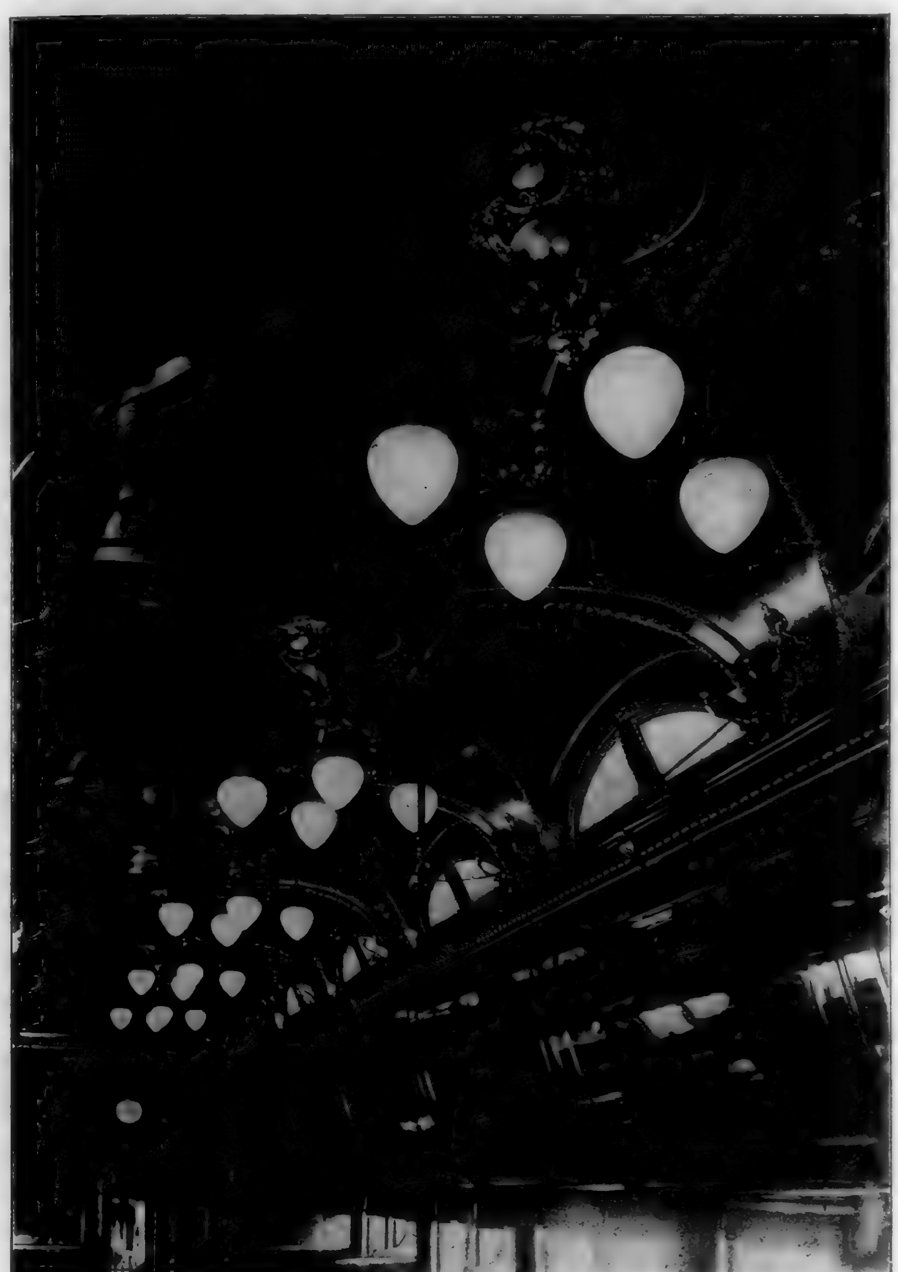

APPLICATION OF THE NEW MANTLE LAMP USING PINTSCH GAS.

The results obtained can be appreciated when it is understood that the illumination given is 33 candles per foot of Pintsch gas used, or an efficiency of about three times that given by the present standard Pintsch lamp for the same consumption of gas, and actual service tests indicate that the life of the mantle is at least three months. The ease of renewing the mantles, the absolutely smokeless flame and the cleanliness insured add to the list of advantages which should be mentioned. The simplicity, efficiency and economy of the Pintsch system are retained in using this light, and in cases where it is decided to adopt the new light a very important saving would be made, because the lighting equipment as now used on the majority of cars throughout the country is available, and only the small cost of renewing the lamp fixtures is involved.

As the working parts of the lamp are simple and compact, the ornamental features will not be limited thereby, and as the illustration shows, the lamp can be made to enter largely into the decorative scheme of the car.

The further extension of supply stations of the Pintsch Company during the last year makes the gas available in all parts of the United States, Canada and Mexico, and at places where only a small supply is required the policy of the company is to furnish transport holders to be placed on flat cars running to the gas plants for charging.

BALTIMORE & OHIO WATER SERVICE.

The Baltimore & Ohio Railroad is making extensive improvements in the supply of water for use in its locomotives. President Murray has recently authorized improvements on the line of the system between Connellsville and Pittsburg, which includes the establishing of water treating plants at Emblem and Glenwood. This work will cost in the neighborhood of $150,000. At Layton the present reservoir capacity will be increased. At Griffin a fairly good mountain stream has been located, which is to be dammed and furnish water at this point by gravity. At Emblem it will be necessary to continue the use of the river water, and, to use this

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BALTIMORE & OHIO WATER SERVICE.

The Baltimore & Ohio Railroad is making extensive improvements in the supply of water for use in its locomotives. President Murray has recently authorized improvements on the line of the system between Connellsville and Pittsburg, which includes the establishing of water treating plants at Emblem and Glenwood. This work will cost in the neighborhood of $150,000. At Layton the present reservoir capacity will be increased. At Griffin a fairly good mountain stream has been located, which is to be dammed and furnish water at this point by gravity. At Emblem it will be necessary to continue the use of the river water, and, to use this

satisfactorily, a purifying plant of 30,000 gals. capacity per hour is to be installed. This plant will also furnish a supply of water that will be carried to Versailles by gravity. At Glenwood it is also necessary to use the river water, and a purifying plant of about 100,000 gals. capacity per hour will be constructed. At Delmar, the Allegheny River water will be piped to suitable storage tanks. The recent annual droughts in this district have resulted in the river waters becoming badly contaminated and polluted by the refuse from mines, mills and decaying of animal and vegetable matter, and this has resulted not only in the scarcity of supply, but in a water that is entirely unfit for locomotive purposes, and the consequence has been an unlimited expense and delay in the handling and maintenance of power, and in the movement of traffic. Where an ample supply of water is available, the best method is to provide reservoirs of sufficient capacity to tide over during the dry season and to supply water by gravity during the entire year. At quite a number of places such a supply cannot be provided, and in these cases it is necessary to make use of the river waters, and treat them by a combined mechanical and chemical process in order to eliminate the impurities and acids, which attack the sheets and flues of locomotive boilers, causing serious leakage and other interference with the movement of the power. The making of these improvements in the source of supply, and for the treatment of impure waters, will relieve the conditions that have existed in this district each fall for some years past, and will enable the more prompt movement of the traffic during the fall and winter season.

APPRENTICE EDUCATION—LONDON & SOUTHWESTERN RAILWAY.

In March, 1903, Mr. D. Drummond, locomotive engineer of the London & Southwestern Railway, instituted a plan (see American Engineer, February, 1904, page 49) for sending apprentices, during working hours and at the expense of the company, to the Battersea Polytechnic Institute for special courses of instruction. This school is near the Nine Elms shops of this road and the boys return to the shops from the school. Mr. Sidney H. Wells, principal of the school, gives the following account of experience with this plan:

"This year, 87 apprentices are in attendance at classes, being divided into three sets, A, B and C. Set A numbers 13 students, and as they attended for a first year course last year, they are now taking a second year course as follows: Tuesdays, 8 to 9, practical mathematics, Stage II.; Fridays, 8 to 10.30, steam and heat engines, lectures one hour followed by laboratory class of 1½ hours. The work taken by this class last year was first year applied mechanics and practical mathematics. Set B numbers 28, and attends on Mondays, 8 to 9, for practical mathematics, and Wednesdays, 8 to 9.30, for applied mechanics. The majority of these also attended last year for the same subjects in a more elementary stage. Set C numbers 46 students who attend this year for the first time. They take elementary practical mathematics on Thursdays, 8 to 9, and elementary applied mechanics on Saturdays, 8 to 9.30.

"The apprentices attend the classes at the times stated instead of going to the works from 6 a. m., and they return to the works after leaving the classes. Their wages are paid by the company as though present at the works from 6 a. m., and the company also pays the class and examination fees. Home work is set regularly and is required to be done by all the students.

"We are now nearing the end of our second year's work with these classes, and we can only say that, in our opinion, they are far in advance of evening classes with regard to punctuality and regularity of attendance, performance of home work, interest displayed, and in quantity and quality of work got through. The company gives prizes to the students who stand highest at the yearly examinations, and I believe it is proposed to give the best students, after a three years' course here, the opportunity of taking a higher or university course at a day college with a view to taking an engineering degree.

"This experiment of early morning classes for apprentices is, I believe, the first of its kind to be tried in this country, and I think very great credit is due to the London & Southwestern Railway and to Mr. Drummond for undertaking it; if only that it shows the apprentices that the company is really interested in their securing technical education, the movement does immense service. There is no doubt that much better work can be done in such classes than in evening classes, where the apprentices are naturally physically tired after the day's work."

IMPROVEMENTS IN SLEEPING CARS.

An improved sleeping car, brought out by the American Palace Car Company, which has been operated in this country for several years, merits serious attention by those who desire to improve sleeping cars. For twenty years there has been no permanent improvement in principle in the sleepers operated on American railroads. The system of the American Palace Car Company embodies all of the improvements and improved facilities of the Pullman sleeping cars and the Pullman parlor cars contained in one car, which, in the daytime, is provided with movable chairs, and at night is made up into berth sections, the chairs being stowed below the floor in the spaces occupied by the berth sections when those sections are not in use; thus the earning capacity of two cars is represented in the cost of construction of one. The construction of the car permits of a thorough and complete system of ventilation, which thus far has never been accomplished in a Pullman car. In this improved car the upper berth offers the same advantages of light, air and observation as that provided in the lower berth, the upper berth, therefore, becoming a comfortable space instead of a disagreeable box. The new car provides berth supports from below, leaving the side of the car free for an extension of the windows of from 10 to 12 ins. above the top of the berth. The upper berths are removed from the interior of the car during the daytime and stowed with the lower berths in steel berth pockets under the floor. In the daytime, instead of the fixed seats, half of which face the rear, the passengers are all provided with comfortable chairs, which may be moved about. Sections may be made up in three minutes, and the lower berth is a comfortable bed instead of a hard sofa. The car differs from ordinary construction in extending the body below the floor between the trucks, in order to provide space for the berths to collapse into during the daytime. This car is one which should interest railway officials, because it possesses very desirable improvements.

Waste Gas in Coking Coal.—In the coking of 1 ton of coal there become available, and are only too frequently wasted, about 2,500,000 British thermal units, sufficient to develop in gas engines at least 205 effective h.p. hours. Thus, for every 11 lbs. of coal coked per hour 1 effective h.p. is available as a by-product.—*Mr. Max Rotter, Illinois Steel Works Scientific Club.*

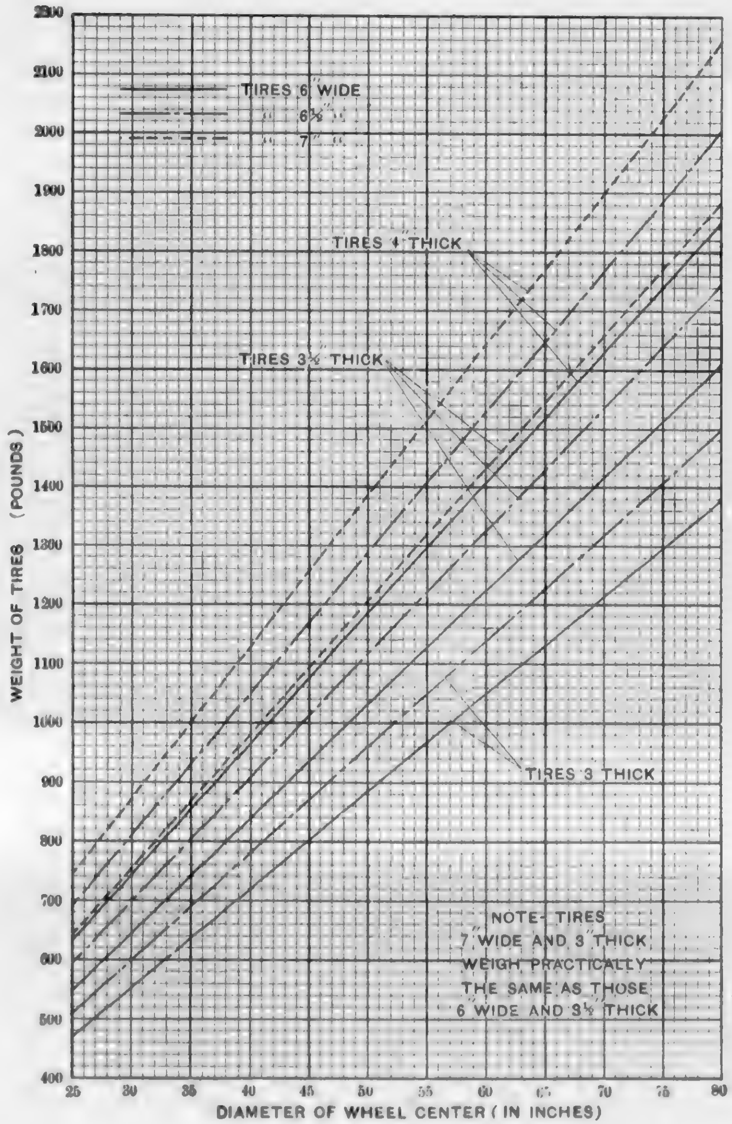
Consumption of India Rubber.—Rubber importations into the United States have grown from 10,000,000 lbs. in 1884 to 44,000,000 lbs. in 1904; the average value per lb. of the crude rubber has advanced in this time from 43 cents to 70 cents, and the total quantity imported in the crude state from 23,272,000 lbs. to 61,890,000 lbs. Doubtless the extension of electrical distribution has accounted for a large proportion of this increase.

Electricity on Steam Railroads.—In a paper read before the Western Railway Club Mr. Clement F. Street, commercial engineer of the Westinghouse Electric & Manufacturing Company, presented a very large amount of data covering the cost of operation of electric and steam railroads, including valuable tables, from which comparisons of costs may be drawn. This is a valuable addition to the literature on the subject, and as the paper cannot properly be presented in abstract, readers are advised to secure copies of the paper itself from Mr. J. W. Taylor, 658 The Rookery, Chicago, Ill.

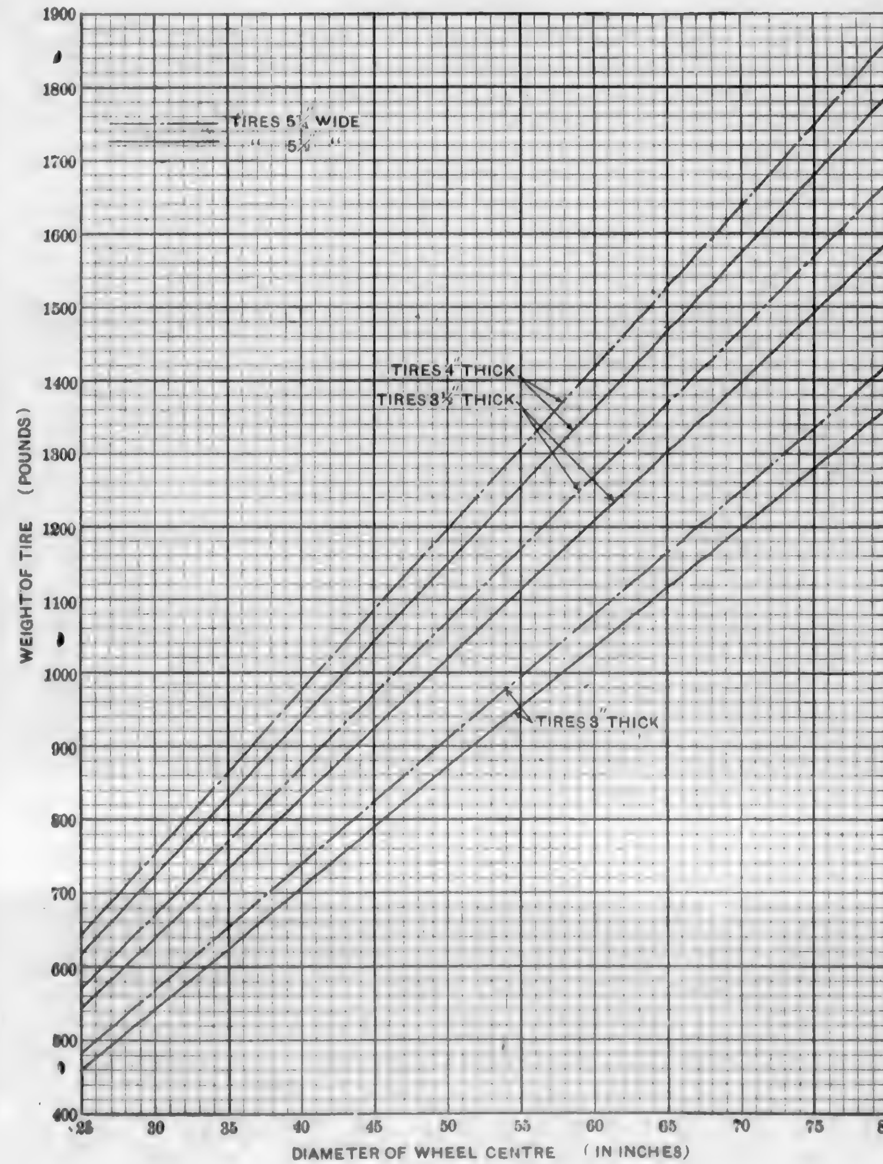
WEIGHTS OF DRIVING-WHEEL TIRES.

By means of the accompanying diagrams, it is possible to quickly find the weight of flanged and plain driving wheel tires of various widths and thicknesses for wheel centers from 25 to 80 ins. in diameter. For instance, to find the weight of a flanged tire 3 ins. thick and 5¾ ins. wide for a wheel center 53 ins. in diameter, it is only necessary to follow the vertical from the point 53 on the base of the diagram for flanged tires until it intersects the dot and dash line marked "Tires 3 ins. thick," and the horizontal from this point of intersection indicates that the tire weighs 960 lbs.

To find the weight of a plain tire 4 ins. thick and 6 ins. wide for a 57-in. wheel center follow the vertical from the point 57 at the base of the diagram for plain tires until it intersects the full line marked "Tires 4 ins. thick." The horizontal through this point of intersection indicates that the weight is 1,340 lbs.



WEIGHT OF PLAIN DRIVING WHEEL TIRES.



WEIGHT OF FLANGED DRIVING WHEEL TIRES.

PLANER TYPE MILLING MACHINES.

It is surprising to find that this type of machine is not more generally used in railroad shops when the advantages gained from its use in manufacturing establishments are considered. In one or two railroad shops machines of this type were found to be lying idle for a considerable portion of the time, but an investigation showed that they had been built a number of years ago, and both the strength of the machine and the driving power provided were entirely inadequate for using the high-speed cutters. It was almost pitiful to watch the slow feeds which it was necessary to use in order to keep within the limits of the machine, and it is no wonder that they were unable to compete with the more modern tools of other types.

Modern machines of this type are designed to rigidly support the cutters, and with plenty of power for operating the feed and the cutter so that the rate of doing the work depends on the strength of the cutter rather than on the machine. A large amount of work usually done on planers and shapers may be handled to advantage on such a machine, and this is especially true for irregular shapes if there is a sufficient number of each kind to be machined to warrant making special gang cutters with which several surfaces may be quickly and accurately machined at the same time.

It is important that the cutters be properly made and cared for. Too slow a feed will often injure them, as it is necessary for the teeth to cut into the surface, and not skim or rub over it. It must be kept in mind that what may seem like a heavy feed will prove very small if resolved to the thickness of cut per tooth and compared to that taken by a lathe or planer tool.

While the acompanying illustrations are not of work actually handled in railroad shops, yet it is very similar in many respects, and serves to give some idea of the rate at which the metal may be removed, and of the large saving in time where it is possible to use gang cutters on irregular surfaces. Fig. 1 shows five cast iron journal boxes being milled on an 84-in. Becker-Brainard planer type miller. The gang cutter finishes six surfaces at one time, feed 4 ins. per minute, cut 5-16 in. deep and 6 ins. wide; cutting speed of largest cutter, 40 ft. per minute. Ten minutes were required to set the boxes on the machine and 20 minutes to machine them. A very smooth finish was required, or the operation could have been done in less time.

Fig. 2 shows a number of cast iron steam chest covers being milled on a No. 32 Becker-Brainard miller. The peripheral speed of the cutter is 40 ft. per minute, the rate of feed 4 ins. per minute, the size of cut ⅛ in. deep and 20 ins. wide. Fig. 3 shows the first operation of milling several steel connecting rods on a Becker-Brainard miller. Four surfaces are being milled at the same time. The peripheral speed of the largest cutter is 24 ft. per minute, and the feed is 1½ ins. per minute. The second operation on these rods is shown in Fig. 4. A 10-in. cutter, 4 ins. wide, is taking a cut its full width and 1 in. deep, and at the same time is taking a 2-in. side cut. The cutting speed is 24 ins. per minute and the feed one in. per minute.

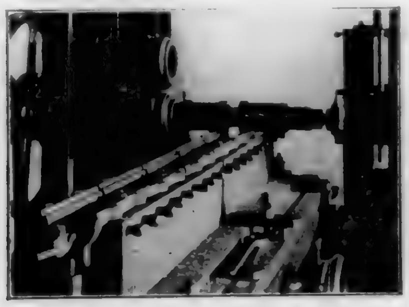


FIG. 1.

FIG. 2.

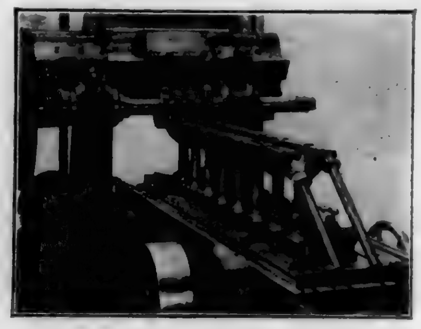


FIG. 3.

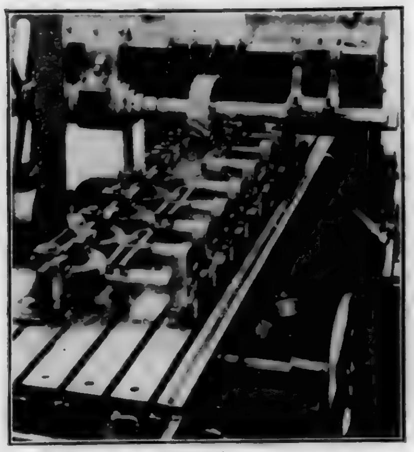


FIG. 4.

EXAMPLES OF WORK DONE ON SLAB MILLING MACHINES.

THE INTERNATIONAL RAILWAY CONGRESS.

The Congress to be held in Washington, D. C., May 3d-14th, has arranged its program as follows: Wednesday, May 3d, from 11 a. m. to 2 p. m., registration of members at the office of the general secretary, New Willard Hotel. May 4th, 11 a. m., formal opening of the session in the banquet hall of the New Willard Hotel. Election of officers.

The sections are to meet as follows: First section, at the Ebbitt House; second section, at the New Willard Hotel, north end; third section, at the New Willard Hotel, south end; fourth section, Raleigh Hotel; fifth section, rooms of the Interstate Congress Commission, F street. Meetings of the sections will be held at 9:30 a. m. and 2 p. m., May 5th, 6th, 8th, 9th and 10th. At 9:30 a. m., May 11th, 12th and 13th, additional meetings of the sections will be held, and at 2 p. m. of these three days general meetings. The congress will formally close at the general meeting at 2 p. m., Saturday, May 13th.

Sunday, May 14th, the foreign delegates will depart on tours of inspection tendered to them. Special tours are arranged for New York City May 1st and Philadelphia May 2d.

A tentative program for Washington has been arranged as follows: May 3d, general view of Washington and visit to the Washington Monument in the morning. Elaborate opening ceremonies of the railway supplies exhibition are arranged for the afternoon of that day, and a midnight signal around the world will be sent that night. May 4th, excursion to Mount Vernon in the afternoon. May 5th, visit to the public buildings. May 6th, open. May 8th, visits to the departments of state, war, navy and the treasury. May 9th, new terminal of the Washington Terminal Company and the new Union Station. Banquet by the American Railway Association to the foreign delegates in the evening. May 10th, Navy Yard and gun foundry. May 11th, Smithsonian Institute and National Museum. May 12th, visit to the Pension Office. May 13th, visit to Arlington and Fort Meyer; an exhibition drill of the troops.

Two special tours will follow the closing of the convention. The short tour leaves Washington on the evening of May 14th; Altoona, May 15th; Pittsburg, May 16th; Cleveland, May 17th; Buffalo, May 18th and 19th; Schenectady, May 20th; Boston, May 21st and 22d, arriving at New York May 23d, after a trip of about 1,500 miles. The long tour leaves Washington on the evening of May 14th; Altoona, May 15th; Pittsburg, May 16th; Cincinnati, May 17th; St. Louis, May 18th; Chicago, May 20th, 21st and 22d; Buffalo, May 23d; Montreal, May 24th; Saratoga, May 25th; Schenectady, May 26th; arriving at New York on the evening of May 27th. The length of this trip is about 2,700 miles. Extensive programs have been arranged for all of the cities visited, and special trains will be provided for each tour.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND—ERIE RAILROAD.

4—4—2 ATLANTIC TYPE.

The Baldwin Locomotive Works have recently supplied two very powerful 4-cylinder balanced compound passenger locomotives for the Erie Railroad, the purpose being to handle 0-ton trains with fast schedules on a crooked, hilly road. Trains of this weight require more powerful locomotives than those previously in service on this road, and the Baldwin Works developed this design with 16 and 27 by 26-in. cylinders, with 115,500 lbs. on driving wheels, or 28,875 lbs. per wheel, and gave the boiler 3,657 sq. ft. of heating surface in order to meet these requirements. The tractive power is 28,000 lbs. This is the largest and most powerful locomotive of this type thus far constructed. The reports of service up to date are entirely satisfactory. The locomotive is illustrated by a photograph, which shows the tender of 8,500 gals. capacity. The leading dimensions of this engine are presented in the following table:

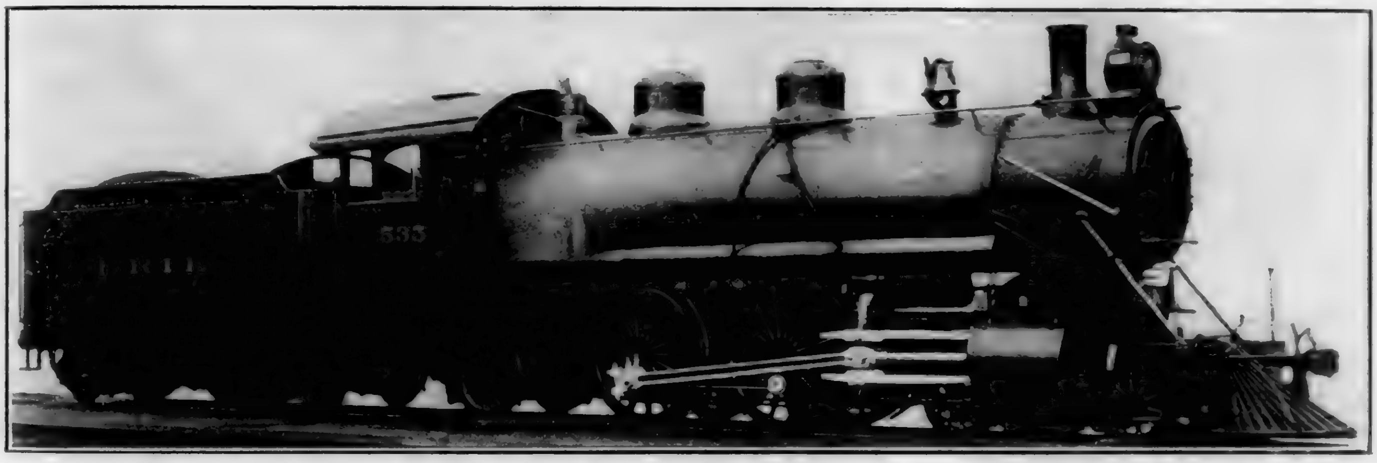
VAUCLAIN BALANCED COMPOUND—ERIE RAILROAD.
4—4—2 TYPE.

Gauge	4 ft. 8½ ins.
Cylinder	16 ins. and 27 ins. by 26 ins.
Valve	balanced piston
BOILER.	
Type	wagon top

Total engine	30 ft. 1 in.
Total engine and tender	59 ft. 10 ins.
WEIGHT.	
On driving wheels	115,500 lbs.
On truck, front	47,500 lbs.
On trailing wheels	41,200 lbs.
Total engine	204,200 lbs.
Total engine and tender	about 356,000 lbs.
TENDER.	
Wheels, number	8
Wheels, diameter	33½ ins.
Journals	5½ ins. by 10 ins.
Tank capacity	8,500 gallons water; 12 tons coal
Service	passenger

Automatic Couplers.—A paper by Mr. A. W. Gibbs, general superintendent of motive power of the Pennsylvania Railroad, on this subject, to be presented at the approaching convention of the International Railway Congress at Washington, traces the development of automatic couplers in this country, illustrates the leading types and shows the influence of the safety appliance law on the application of these devices. Throughout the report references are given to articles and reports referring to couplers. This paper is an exceedingly complete and important document upon this subject.

Earliest Record of Superheating.—Superheating is by no means a new thing. It was proposed by Joseph Hateley in 1768 (Specification of Patent No. 895 of 1768).—*R. Neilson, in Engineering Magazine.*



POWERFUL BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD.

G. W. Wildin, *Mechanical Superintendent.* Baldwin Locomotive Works, *Builders.*

Material	steel
Diameter	68 ins.
Thickness of sheets	11-16 in. and ¾ in.
Working pressure	225 lbs.
Fuel	soft coal
Staying	radial
FIRE BOX.	
Material	steel
Length	108⅛ ins.
Width	72 ins.
Depth, front	71½ ins.
Depth, back	69 ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	½ in.
WATER SPACE.	
Front, sides and back	4 ins.
TUBES.	
Material	iron
Wire gauge	No. 12
Number	309
Diameter	2¼ ins.
Length	19 ft.
HEATING SURFACE.	
Fire box	186.2 sq. ft.
Tubes	3,422.8 sq. ft.
Firebrick tubes	28 sq. ft.
Total	3,657 sq. ft.
Grate area	54 sq. ft.
DRIVING WHEELS.	
Diameter, outside	72 ins.
Diameter, inside	66 ins.
Journals, front	10 ins. by 10½ ins.
Journals, back	9 ins. by 12 ins.
ENGINE TRUCK WHEELS.	
Front, diameter	33½ ins.
Journals	6 ins. by 12 ins.
TRAILING WHEELS.	
Diameter	44 ins.
Journals	8½ ins. by 12 ins.
WHEEL BASE.	
Driving	7 ft.
Rigid	16 ft.

Evening Classes, Grand Trunk Railway.—The forty-seventh annual report of the Literary and Scientific Institute of the Grand Trunk Railway shows an average attendance in the mechanical drawing classes of 76, with other classes in proportion. The attendance of the evening classes during the season was 3,358. The classes for the study of locomotive models and air brake sections numbered 750. The total membership in the institute is 777. Members pay fees of one dollar per year and are entitled to privileges of the library and reading room, the use of models, and free admission to lectures and classes. It seems strange that such a good work as this could have been conducted for forty-seven years in Montreal without attracting more attention on this side of the border line.

One and One-Half Millions of Dollars in Pensions.—The statistics of the Pennsylvania Railroad Pension Department, compiled, show that during the five years of its operation pension allowances have been paid to the retired employes of the company the sum of $1,614,087.59. The above expenditure does not include the expenses of operation of the department, which is also borne by the company. During the five years 2,418 employes have been retired as pensioners from active service, of which number 700 have died. Of the total number retired 568 were between the age of 65 and 69 years, of whom 439 were retired on their own request with the approval of the employing officer.

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Modern machines of this type are designed to rigidly support the cutters, and with plenty of power for operating the feed and the cutter so that the rate of doing the work depends on the strength of the cutter rather than on the machine. A large amount of work usually done on planers and shapers may be handled to advantage on such a machine, and this is especially true for irregular shapes if there is a sufficient number of each kind to be machined to warrant making special gang cutters with which several surfaces may be quickly and accurately machined at the same time.

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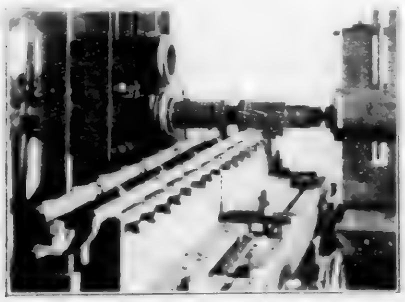


FIG. 1.

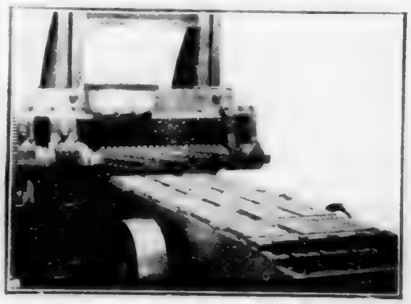
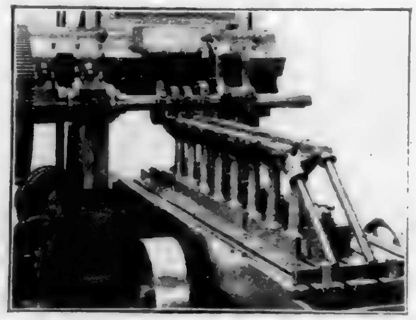


FIG. 2.



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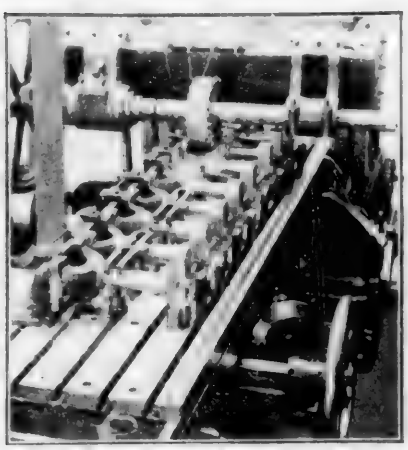

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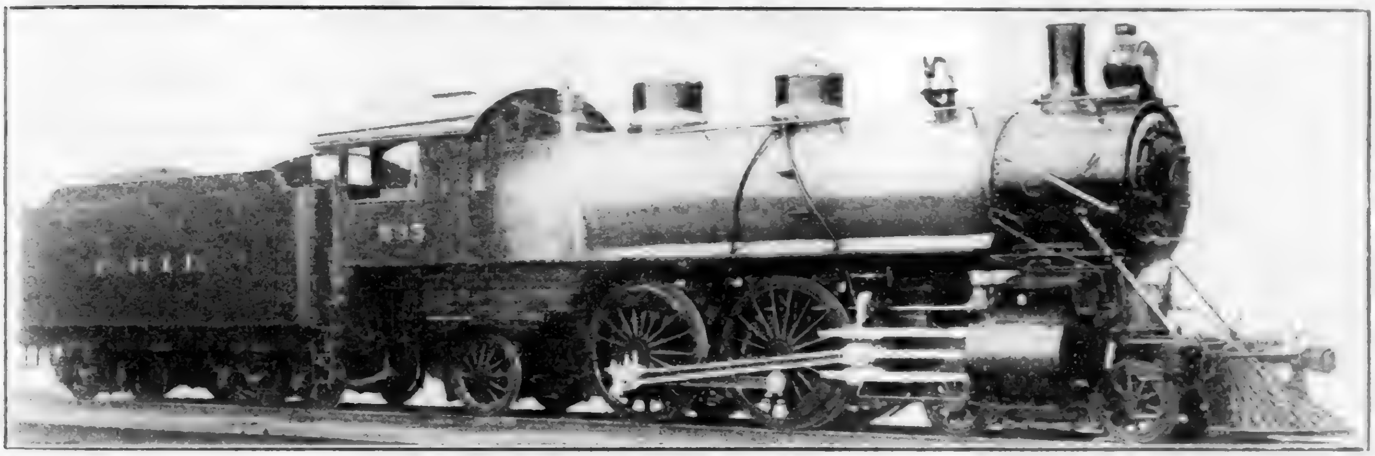

POWERFUL BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD

G. W. WILDIN, *Mechanical Superintendent.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

[illegible]	4 ft. 8½ ins.
[illegible]	16 ins. and 27 ins. by 26 ins.
[illegible]	balanced piston
BOILER.	
[illegible]	wagon top
Material	steel
Diameter	68 ins.
Thickness of sheets	11-16 in. and ¾ in.
Working pressure	225 lbs.
[illegible]	soft coal
[illegible]taying	radial
FIRE BOX.	
Material	steel
Length	108⅛ ins.
Width	72 ins.
Depth, front	71½ ins.
Depth, back	69 ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	½ in.
WATER SPACE.	
Front, sides and back	[illegible] ins.
TUBES.	
Material	iron
Wire gauge	No. 12
Number	[illegible]
Diameter	2¼ ins.
Length	19 ft.
HEATING SURFACE.	
Fire box	186.2 sq. ft.
Tubes	3,422.8 sq. ft.
Firebrick tubes	28 sq. ft.
Total	3,657 sq. ft.
Grate area	54 sq. ft.
DRIVING WHEELS.	
Diameter, outside	72 ins.
Diameter, inside	66 ins.
Journals, front	10 ins. by 10½ ins.
Journals, back	9 ins. by 12 ins.
ENGINE TRUCK WHEELS.	
Front, diameter	33¼ ins.
Journals	6 ins. by 12 ins.
TRAILING WHEELS.	
Diameter	44 ins.
Journals	8½ ins. by 12 ins.
WHEEL BASE.	
Driving	7 ft.
Rigid	16 ft.
Total engine	[illegible]
Total engine and tender	[illegible]
WEIGHT.	
On driving wheels	15,500 lbs.
On truck, front	17,500 lbs.
On trailing wheels	11,200 lbs.
Total engine	[illegible]
Total engine and tender	[illegible]
TENDER.	
Wheels, number	[illegible]
Wheels, diameter	33½ ins.
Journals	[illegible] by 10 ins.
Tank capacity	[illegible]
Service	[illegible]

AUTOMATIC COUPLERS.—A paper by Mr. A. W. Gibbs, general superintendent of motive power of the Pennsylvania Railroad, on this subject, to be presented at the approaching convention of the International Railway Congress at Washington, traces the development of automatic couplers in this country, illustrates the leading types and shows the influence of the safety appliance law on the application of these devices. Throughout the report references are given to articles and reports referring to couplers. This paper is an exceedingly complete and important document upon this subject.

EARLIEST RECORD OF SUPERHEATING.—Superheating is by no means a new thing. It was proposed by Joseph Hateley in 1768 (Specification of Patent No. 895 of 1768).—*R. Neilson, in Engineering Magazine.*

EVENING CLASSES, GRAND TRUNK RAILWAY.—The forty-seventh annual report of the Literary and Scientific Institute of the Grand Trunk Railway shows an average attendance in the mechanical drawing classes of 76, with other classes in proportion. The attendance of the evening classes during the season was 3,358. The classes for the study of locomotive models and air brake sections numbered 750. The total membership in the institute is 777. Members pay fees of one dollar per year and are entitled to privileges of the library and reading room, the use of models, and free admission to lectures and classes. It seems strange that such a good work as this could have been conducted for forty-seven years in Montreal without attracting more attention on this side of the border line.

ONE AND ONE-HALF MILLIONS OF DOLLARS IN PENSIONS.—The statistics of the Pennsylvania Railroad Pension Department, compiled, show that during the five years of its operation pension allowances have been paid to the retired employes of the company the sum of $1,614,087.59. The above expenditure does not include the expenses of operation of the department, which is also borne by the company. During the five years 2,418 employes have been retired as pensioners from active service, of which number 700 have died. Of the total number retired 568 were between the age of 65 and 69 years, of whom 439 were retired on their own request with the approval of the employing officer.

PRODUCTION IMPROVEMENTS.

CHICAGO SHOPS—CHICAGO & NORTHWESTERN RAILWAY.

Fourteen bull rings, from 15 to 22 ins. in diameter, are completed in these shops in 8 hours on a stiff 28-in. Pond lathe, purchased about three years ago. Sixty-four piston packing rings, varying from 15¼ to 22 ins. in diameter, are finished on the same machine in 8 hours. This machine is used to supply bull and packing rings for the entire road, and is also available a large part of the time for other work.

To do this work an excellent expansible chuck and a four-sided turret for the tool post have been developed under the direction of Mr. Oscar Otto, general foreman. These are shown in the accompanying photographs.

The chuck itself is bolted to a flange carried on the lathe spindle. The body of the chuck carries segments, or shoes, which are adjustable radially by means of the cone shown at the left in the first photograph. Various sizes of the segmental pieces are provided for wide changes in diameters of the bull rings. The tail stock center is moved up against the spindle to illustrate the tools. At A are the centering rollers, used to center the packing rings before the cone of the chuck is tightened up for cutting. At B are the roughing tools for the outer surfaces of the rings. At C are the roughing tools for the sides of the rings, and at D are the tools for finishing both the sides and the cylinder wearing surfaces, the wearing surfaces being finished with slight grooves. The segmental pieces for holding two packing rings at once are in the form of equalizers, pivoted at the center in order to secure a satisfactory bearing on both rings at once.

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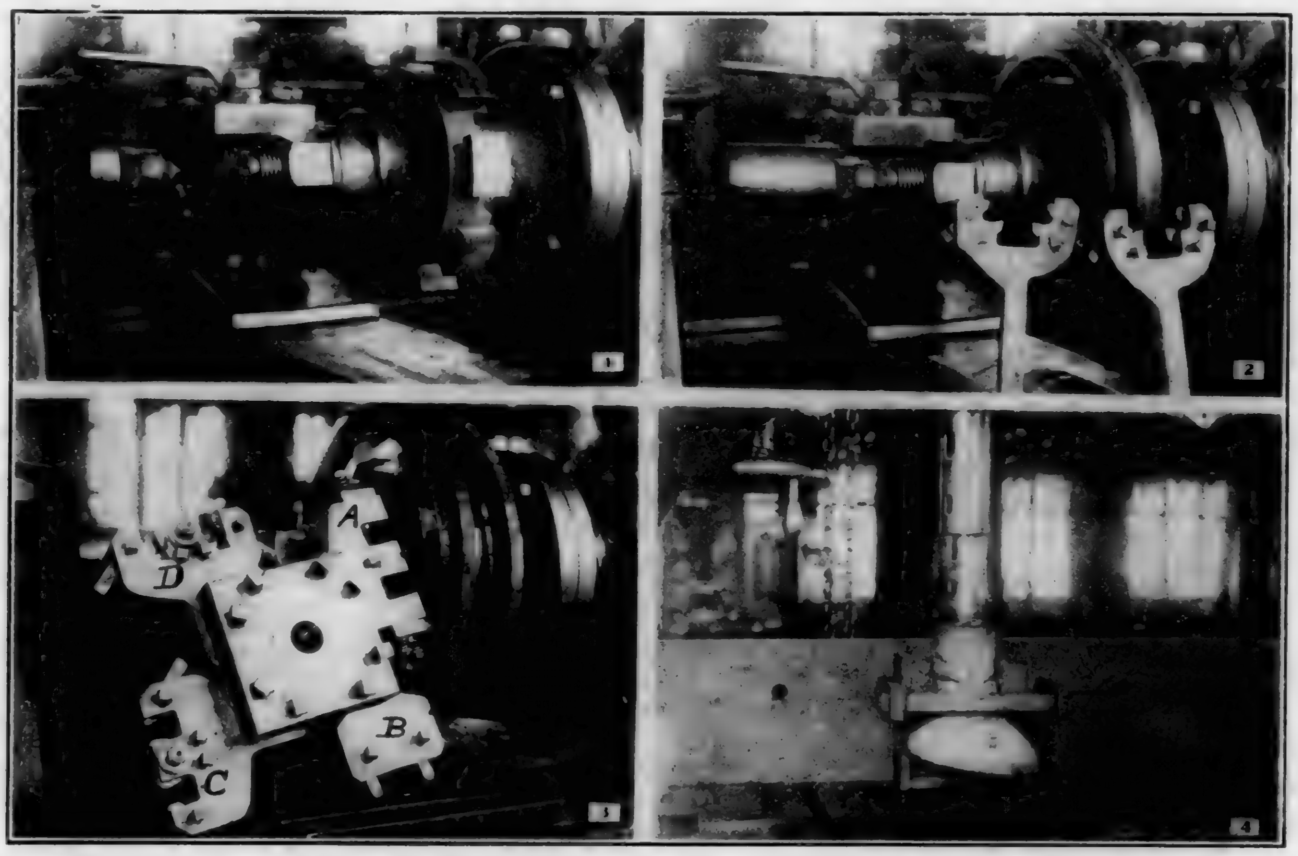

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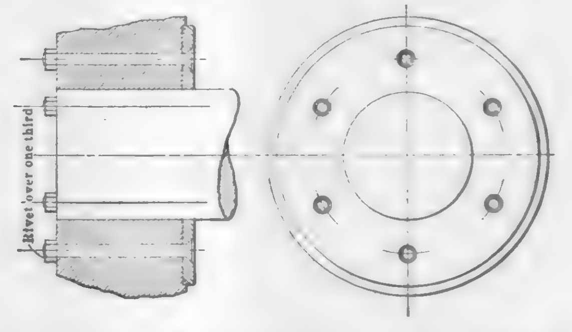

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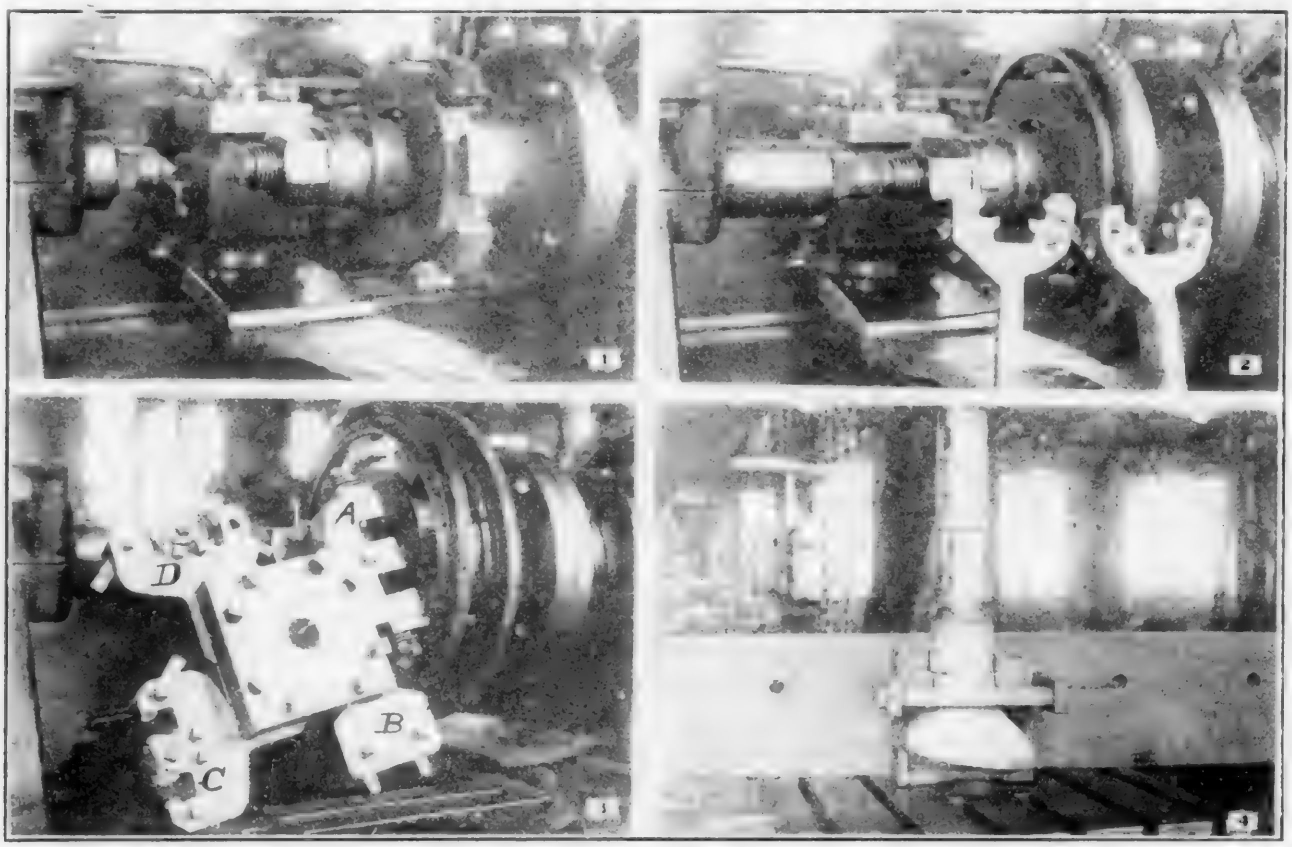

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time comes young men will not have to look elsewhere for good positions. In the meantime this department at least offers a wonderful field to the ambitious college man who is anxious to gain a broad mechanical experience in a short time.

M. N. O.

WATER SOFTENING.

To the Editor:

The writer has noted the comments of Mr. A. McGill in a letter to your paper in March, page 92, in which it is directly or indirectly claimed that the system of tests mentioned in the series of articles on water softening is too delicate and entirely beyond any one but an expert, that such tests are unnecessary, that badly fluctuating water should not be used, that the soap test is most inaccurate, and that "there are elegant and accurate modes of doing what it (the soap test) proposed to do."

It is difficult to see the connection between a watch and water treatment, but if the illustration must be used it suffices to say that all that is demanded of the workman is that he wind the watch. It is expressly stated in the general article that the attendant is not held responsible in any way for the quality of the treated water. He does not have to make any repairs or do any thinking about charges or changes in charges. By referring to page 37 in the March number, it will be noted that the writer admits that the system of control *may appear at first glance* to be "intricate, difficult to follow and costly in operation." But the reverse of this is the case. Its workings have been smooth and accurate and undoubtedly excellent results have been obtained. The system is all but automatic in its operation. Mr. McGill has entirely missed one vital point, and that is that the scheme of analysis and control objected to is not a proposed one, but is one which in part has been in service for a year and a half and in full in its present shape for nine months. The tests are being made every day with great precision and success by common labor; some of the men can do little more than read and write, and not one has any theoretical knowledge whatever of chemistry. The tests are so simple that a child could make them and make them so accurately after a short experience that it would be hard for an expert chemist to surpass them. The time taken for a complete set of tests is from 10 to 25 minutes once or twice a day, and the danger of confusing tests or chemicals is entirely negligible. It may be repeated that these tests are not theory but practice, they have been working absolutely satisfactorily for nine months, despite the fact that during that time there have been at some of the softeners six or seven different attendants. In the light of such facts, the statements that these tests are beyond the ordinary workman are entirely incorrect.

It is impossible to satisfactorily treat river waters in a commercially active hilly country, such as is the neighborhood of Pittsburgh, without tests at the point of treatment. The waters in the rivers are continually changing, every rain effects them and every dry spell, not to speak of the pollution, which fluctuates but is always present. It is possible to treat stationary well water without local testing, but even there results could be improved if local tests were made. Mr. McGill states: "It may be well to send daily samples to some central laboratory in order that we may be sure that everything is going properly." That is taken care of in the scheme outlined in the general article; but how can results be satisfactory if proper charges are not made, and how can proper charges be made if proper tests are not made and made in time to effect the treatment? To show the variation, the following list of consecutive charges of soda during the last three weeks of December, 1904, at Buena Vista, is given, every charge treated the same amount of water: 247, 276, 331, 325, 312, 305, 299, 397, 324, 294, 300, 258, 258, 366, 366, 354, 348, 242, 210, 210, 30, 39, 36, 45, 45, 39, 39, 54 pounds. Surely it is not claimed that such waters could be treated by long distance testing.

On railroads water is required at certain fixed points and consequently the best available supply at the point must be used. The Pittsburgh & Lake Erie Railroad Company have spent large sums of money in investigating the available sources of water supply and have considered wells, long pipe lines, river water, etc., and have, it is needless to say, decided on what is, in their opinion, the right water, which of course, is very largely a matter of dollars and cents, not the initial but the ultimate cost. If a good water is available it should by all means be used, but if no good water is available, then the best of the bad ones, no matter how fluctuating, must of necessity be made to answer. The next step is the installation of a good softener and a proper system of local testing.

The much beligned soap test; the writer admits that he approached this subject two years ago with some of the general prejudice against it. He was fully aware of the adverse opinion of most of the men referred to by Mr. McGill, and it was only after exhaustive tests, both on the soap and other schemes, that the others were rejected and the soap test adhered to. As mentioned in the regular article, every means is taken to keep conditions uniform, every equipment, even to the bottles, is identical, chemical solutions are almost automatically kept standardized and every man makes his tests in identically the same way. Attention is directed to the comments on the soap test which appeared on page 138 of the April number; the data there given speak for themselves, the number of samples is large enough to show that the agreement is not accidental. Again, the argument of actual use may be used, the soap test along with the other two has given, under trying conditions, most satisfactory results, and consequently the error cannot be great. It is of course a somewhat startling assertion to make, in the face of such authorities quoted by Mr. McGill, that the soap test is reliable, but such a claim is here made in so far as it relates to use in water softening, at least on waters in the vicinity of Pittsburgh. This explanation for the supposed inaccuracy of the soap test is advanced, that the reason the result by soap test disagrees with that by full analysis is that the full analyses have heretofore incorrectly stated the conditions existing in the water, the apportionment of calcium, magnesium, etc., to carbonates, sulphates, chlorides, etc., being on an incorrect basis. The writer has no hesitation in claiming that, if a certain sample of any natural water of this vicinity, except perhaps an acid one, was independently tested for hardness by the soap test by the 10 water softener attendants on the Pittsburgh & Lake Erie Railroad, who are just ordinary untrained men or boys, the results would be the same to within one part per 100,000, and that not one of them would vary by as much as two parts per 100,000 from the hardness obtained from the complete analysis as made by the Pittsburgh Testing Laboratory, and also that if this water were above 25 or 30 deg. of hardness it would be impossible to get results as close from any 10 laboratories in the country, or even half that number. If, then, laboratories disagree, why should not a test which gives uniformly consistent results be used. The disagreement among chemists on water analysis is proverbial. Disagreements could be listed without number, those below are simply taken as a sample, they are from a paper read before the Engineers' Society of Western Pennsylvania, December, 1903, by Mr. J. O. Handy (the initials P. T. L. stand for Pittsburgh Testing Laboratory):

	Parts per 100,000.			
	Bloomington.		Joliet.	
	P. T. L.	H-t.	P. T. L.	H-t.
Carbonate of lime	29.15	3.66	28.29	8.30
Carbonate of magnesia	3.47	16.32	3.44	24.96
Sulphate of lime	1.65	19.75	7.58	42.70
Sulphate of magnesia	16.36	....	34.71	....
Sulphate of soda	....	....	1.12	....
Chloride of soda	3.14	2.93	14.85	13.99
Carbonate of soda	1.97	5.60	1.06	6.73

Substitute for the soap test. There is not a test for hardness published which anywhere approaches for simplicity the soap test or which could be made with precision by common labor, and therefore if it is admitted that tests at the plants are necessary then the soap test cannot be superseded. The test which has been received with the greatest favor is known by the name of the "soda reagent" test, and some able papers have been read by Mr. McGill before the Society of Chemical Industry, Canadian Section, published in their journal for April 15 and May 31, 1904, and an elaborate system of treating based thereon, read before the American Railway Engineers & Maintenance of Way Association, published in bulletin No. 55, September, 1904. As this is the system which Mr. McGill so strongly advocates elsewhere, it is perhaps fair to assume that it is one of those to which he refers as "an elegant and accurate mode . . ." A perusal of these papers referred to will but accentuate the simplicity and relative accuracy of the system in use on the Pittsburgh & Lake Erie Railroad.

The accuracy of the soda reagent method may be judged from the following extract from Mr. McGill's papers referred to, Journal, May 31. (The unit used by Mr. McGill is parts of lime, CaO, per million, the standard used on the Pittsburgh & Lake Erie and used throughout the series of articles on water softening is parts of calcium carbonate, $CaCO_3$, per 100,000, each one unit of the latter is equal to 5.6 units used by Mr. McGill.) "The precipitation of lime and magnesia in these operations is so close that the filtrates give but very faint reactions for these bases when tested, under most rigorous conditions, by oxalate and phosphate,

vided that the filtrates in question are perfectly clear. Never-ess an experience, based upon many hundreds of tests, convinces that an error which may amount to 50 parts per million (i. 8.93 units P. & L. E.) invariably occurs in this method of as-. The whole of the sources of this constantly occurring error not known, but the following list comprises the most im-rtant:—" and then follow the five errors referred to, any one of ich, except the first, is enough to condemn the method. There also a proposed arbitrary addition of 25 parts per million (4.46 P. & L. E. units) to take care of three of the errors, the fifth or, turbidity of the filtrate, is varying and uncertain. Then llows a table showing the relation between the hardness as ob-ined by full analysis and that obtained by the soda reagent, the rst 19 items of which table are reproduced below, with the ad-dition of the last column at the right hand side to reduce the error to the same units as are used in the article on water softening in this journal.

Parts per 1,000,000, Calcium Oxide.

Serial No.	Name.	CaO	By Ordinary Quantitative Analysis. MgOx. 1.4	Sum.	Hardness as CaO by Soda Reagent.	Error.	Error. (P.&L.E. Standard)†
1	Portage	184	176	360	347	13	2.32
2	Calgary	121	160	281	286	* 5	*0.89
3	Regina	219	211	430	414	16	2.85
4	Farm Dam	349	376	725	711	14	2.50
5	Plum Coulee	359	276	535	521	14	2.50
6	Maniton	63	42	105	95	10	1.78
7	Mooris	270	197	467	403	64	12.50
8	Snowflake	494	232	726	689	37	6.60
9	Kincorth	129	102	231	196	35	6.25
10	Lenore	184	141	325	319	6	1.07
11	Binscarth	239	104	343	347	* 4	*0.71
12	Moosomin	298	160	458	437	21	3.75
13	Lillis	234	127	361	330	31	5.54
14	Gretna	354	270	624	622	2	0.35
15	Suffield	106	78	184	151	33	5.89
16	Virden	246	136	382	308	74	13.21
17	La Riviere	121	64	185	179	6	1.07
18	Gull Lake	264	224	488	442	46	8.21
19	Broadview	170	113	283	252	31	5.53

*Excess; all other figures, defect.
†Parts per 100,000 calcium carbonate.

The discrepancy is most marked, only three out of the 19 came within one part per 100,000 of being correct. The variation is from an excess of 0.89 to a defect of 13.21, P. & L. E. standard, and yet this method is claimed to be superior to the soap test. A glance at the first 19 items in the article on page 138 will show the validity of the claim. It is only fair to add that the waters tested just above are, as a rule, harder than those tested on the Pittsburgh & Lake Erie.

With the soda reagent system of testing, the determination of hardness of treated water is absolutely impossible, for of what use is a test for water of about a total hardness of 6 when the admitted average error is in the neighborhood of 5? The soda reagent test for hardness is of course supposed to be used for approximate analysis only; that is also the claim advanced for the soap test. The soap test is not put forward as a scientific analysis of water, but it is claimed that it will give consistent and accurate information concerning the total hardness of water; certainly far within the limit of error granted by Mr. McGill in his concluding paragraphs; a laboratory that will not work far below 10 grains per imperial gallon, 14.3 parts per 100,000, is not worthy of serious consideration, a water softener attendant who would not work to below 30 per cent. of this error would not be retained in the employ of this company; the majority of them can and do work below 10 per cent. of it.

The system of tests and control used on the Pittsburgh & Lake Erie Railroad needs no apology, the results speak for themselves. That they are satisfactory from a chemical standpoint is beyond question. Every facility will gladly be accorded anyone who desires to make a personal investigation.

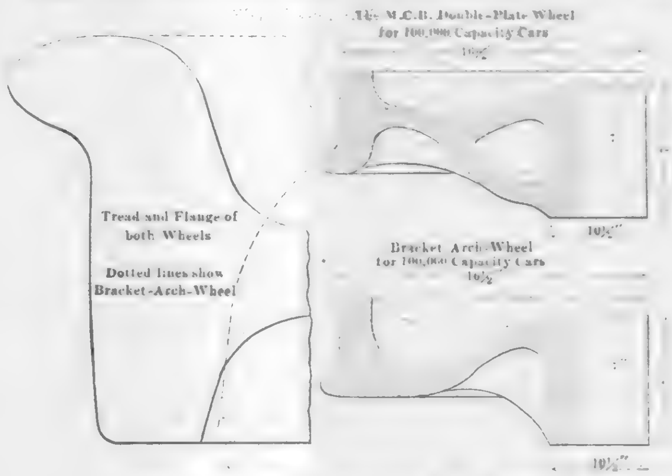
G. M. Campbell.

"BRACKET-ARCH" CAST-IRON CAR WHEEL.

To the Editor:

In this type of wheel there is no double plate nor ring core around the hub. This allows the wheel to be thoroughly inspected and makes it absolutely safe, as any defect can be readily detected. The large amount of grey metal over the flange because the arch plate ends over it, adds additional strength and absorbs and conducts the heat from the flange caused by braking and by friction of the flange against the rail. The arch plate and heavy fillet over the flange prevents the development of seams in the throat of the flange so often met with in the double plate wheels in general use under the modern heavy cars. As the "bracket-arch" wheel takes but half the time required by the double plate wheel, it has better chill, the metal is more regular in grain and the wheel is much stronger. According to the M. C. B. drop and thermal tests this wheel is from 25 to 30 per cent. stronger than the double plate wheel of the same weight and of the same iron. Seven hundred pound wheels of this type are in service under 100,000 lbs. capacity cars on two of the principal roads in the country. This type of wheel is in service on three of the best known railroads in this country.

Single plate wheels were made 50 years ago by Messrs. Whit-



"BRACKET ARCH" CAST-IRON CAR WHEEL.

ney & Son, Philadelphia, and were used on different roads at that time. Hart and Washburn patented a single plate wheel April 3, 1849. But I have no information that any of the type had ever been in service. The single plate wheels that have been patented and those that have been in service previous to the "bracket arch" wheel are very different in construction in several important parts. The "bracket arch" wheel is designed to meet the requirements of the modern 50-ton freight cars and increased speed of trains.

D. P. Rennie.

Louisville, Ky.

Peculiar Tire Wear.—On the Boston Elevated the tires for motor cars wear polygonal, and require grinding once or twice a month. The spots at first are short, then two or more unite, until there are only 16 or 20 for the entire circumference. Between the flattened spots a portion of the metal hardens by the action of the brake shoes, and does not reduce as fast as the other parts of the tread. The microscope shows a series of transverse cracks, indicating a tensile strain on the surface of the metal, exceeding the elastic limit. Between the high portions the treads are scored by a series of irregular diagonal lines across the tread. The rail heads on curves were abraded by forcing the wheel treads diagonally across the top of the rail. The rails of 0.45 to 0.50 carbon, on curves of 90 to 110 ft. radius, were reduced ½ in. in height from 90 to 120 deg. Rails of higher carbon have since been introduced, which wear from four to five times as long.—*P. H. Dudley before Int. Ry. Congress.*

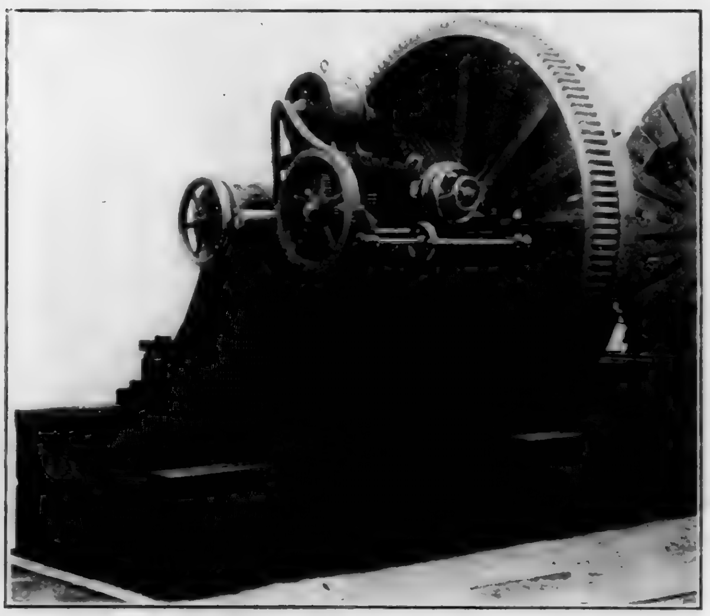
Home Made Scrap Straightening Hammer.—For straightening scrap iron Mr. W. J. Shea, master mechanic of the Illinois Central Railroad at McComb City, Miss., has arranged an 8-in. air brake cylinder on an upright post for use in straightening scrap bar iron at that shop. This simple device is very convenient. It consists of an anvil and post, an old brake cylinder, a valve for operating the cylinder, which is worked by a treadle, and the device is completed by an oil cup for lubricating the piston. By its use a great deal of the scrap material is straightened in the scrap yard by unskilled labor.

Labor Saving, Boiled Down.—The entire gas supply of Oakland, Cal., is made in a single oil gas generator set, having a capacity of 150,000 cu. ft. of gas per hour, requiring the labor of but one man. Oil is used for fuel as well as for the manufacture of the gas, and no coal whatever is handled at the plant.

90-INCH DRIVING WHEEL LATHE.

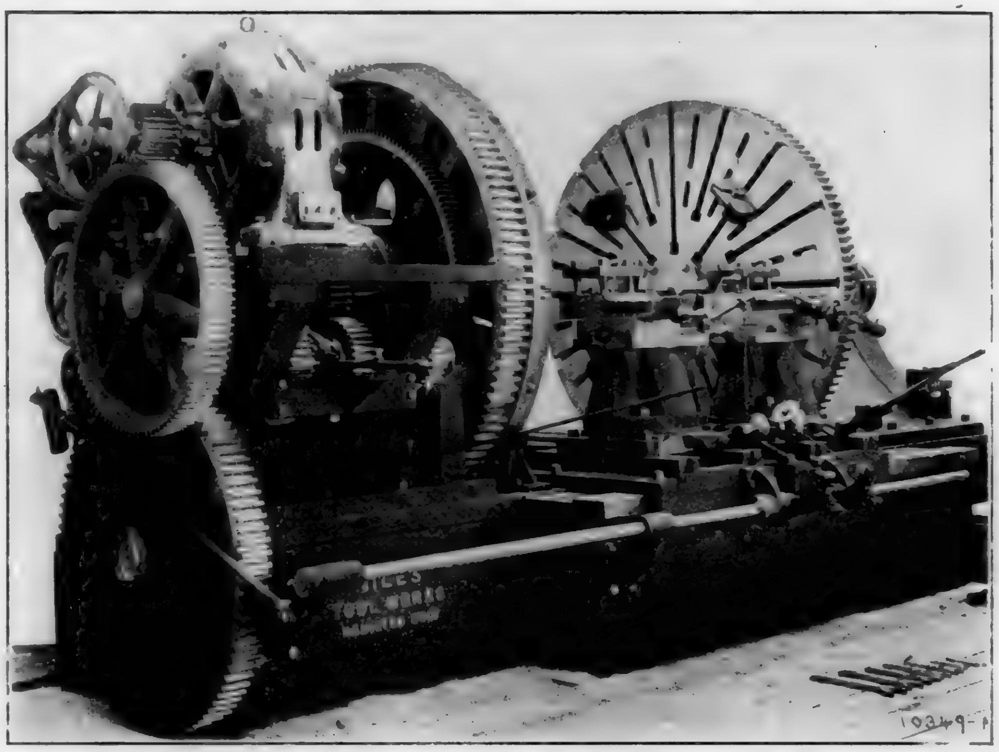
The Pere Marquette Railroad has just installed a Niles new standard 90-in. driving wheel lathe in their shops which is designed to take two cuts ½ in. deep with a 3-32-in. feed, at a cutting speed of 20 ft. per minute, thus removing about 350 lbs. of metal per hour. It has a capacity between face plates of from 6½ to 9 ft. and swings 91 ins. over the bed. The speeds are arranged for turning wheels from 50 to 84 ins. in diameter, and the wheels are taken in or out of the machine without changing the position of the carriages, it being only necessary to move the tailstock sufficiently to the rear to withdraw the crank pins from the openings in the face plates. One man can easily move the tailstock by means of the ratchet and lever, but if desired a 3-h.p. motor may be furnished for this purpose. A 30-h.p. General Electric motor with a speed range of from 400 to 800 r.p.m. is used for the main drive. The quartering attachments are each driven through Morse silent chain by a 3½-h.p. motor with a speed range of from 980 to 1,275 r.p.m.

Each face plate is equipped with four of the new patented chuck driver dogs. These drive through "sure-grip" tool steel jaws engaging at the outer rim of the tread and entirely eliminate all chatter. The arrangement of these driver dogs, together with the ready means of moving the tailstock, and the clear space in front of the carriages (back of the bed) make it possible to largely reduce the time necessary in chang-



REAR VIEW OF DRIVING WHEEL LATHE, SHOWING QUARTERING ATTACHMENT.

ing from finished to new work. The driver dogs are attached to the face plates and therefore it is only necessary that the bolts and clamps be moved. In many instances it has been found possible to drive without the use of the clamps and bolts. The tool rests are of a new design, arranged to reach forward to the minimum diameter of the work. The base is arranged to swivel as usual. The rocker shaft is arranged at the front of the bed and makes 4 vibrations to 1 revolution of the work, in this way dividing the feed of tool into the work and making it more nearly a continuous feed. The feeds are 1-24 in. to ¼ in. per revolution of the work, each increase of one notch on the ratchet is equal to 1-24 in. If desired, the machine may be equipped with adjustable carriages, fitted to the bed at the rear, which support two separate journal turning tool rests.



NILES 90 INCH DRIVING WHEEL LATHE—PERE MARQUETTE RAILROAD.

CHANGES IN DRILLING MACHINE DESIGN.

Less than two years ago a certain railroad changed several upright drills, which were giving satisfactory results using carbon steel drills, from belt to motor drives. At that time high-speed drills were in an experimental stage, and in order to provide for using them, in event of their proving satisfactory, the motors selected were at least 50 per cent. larger than required with the use of carbon steel drills, the spindle speeds were increased considerably, and the motor brackets were made of very heavy design, thus affording a strong back brace for the column and stiffening it against vibration. As the high speed drills came into use it was found that the heavier feeds could not be used to advantage because of the slipping of the feed belts, thus emphasizing the need of a more powerful feed and suggesting the use of a positive feed mechanism. The higher spindle speeds were found to be too low, and the lower ones were seldom used, if at all. In spite of the heavy bracing, there was considerable vibration when the high speeds and coarser feeds were used, and, although these machines were probably as strong as any other standard machine of their size, it was found necessary to humor them considerably on the heavier work.

To overcome defects of this kind, machine tool builders have had to make some radical changes in their standard designs. Columns are being made larger, and in some cases are being strengthened by substantial back braces; coarser feeds and higher spindle speeds and more of them are being provided. In one of the most recent designs the swinging table is done away with, and a compound table very similar to that on an ordinary shaper is used. It is thus possible to support it very rigidly and to make the column of a heavy box form. Another recent design has six positive feeds, ranging from .006 to .039 in. per revolution of the spindle, and change from one feed to another may be made instantly. The heavier duty, caused by the use of the new steels, wore the journals on the

[th]e machines quite rapidly, and it has been found necessary [to] provide larger ones, to use longer bearings and to strengthen [th]e gearing.

Some of the recent motor applications to upright drills [ar]e open to considerable criticism; as a rule, the motor appli[ca]tions to these machines are not as good as those to other [cl]asses of machine tools. Possibly the purchaser is to some [e]xtent responsible for this condition. The sizes and ranges [of] speed of different makes of motors of the same capacity [v]ary so much that the special brackets are a considerable item of expense to the builder, and as the nature of the ma[c]hine is such that belts can be used, it is cheaper to thus [c]onnect the motor to the driving shaft. We even find that in some cases two belts are used in order to make use of tight and loose pulleys. While the first cost of a machine driven in this way may be less, the cost of the maintenance of the belts and the loss of power by this means of transmission will in time offset this saving. There is no reason why the motor cannot be mounted on a substantial bracket and be connected to the driving shaft, either by spur gears or a silent chain, thus making a positive drive.

If high-speed drills have shown up defects in the design of upright drills, they have made even greater trouble for the builders of radial drills. The coarser feeds have greatly increased the upward thrust on the arm, and this and the increased twisting action, due to the saddle being on one side, have made it necessary to very greatly increase the strength of the entire machine. It is an interesting study to see how the various builders are strengthening the parts without increasing the weight of the machine to such an extent as to make it unwieldy. The columns are being made much stronger and more rigid. The arms are being designed as cantilever beams of uniform strength, with the metal distributed to the best possible advantage, thus greatly strengthening them, and in many cases considerably improving their appearance from an engineering standpoint. As a rule, positive feeds are provided, and the motor applications are much better than those to upright drills.

MALLET COMPOUND LOCOMOTIVES, AMERICAN RAILROAD, PORTO RICO.

Four of these locomotives, by the Baldwin Locomotive Works, have gone into service under particularly trying conditions. The road is crooked, the gauge 3 ft. 3⅜ ins., and the steepest grade is about 2 per cent., and the trains are of about 500 tons each. Compounds were desired because of the high cost of fuel, and the character of the track construction would not permit of highly concentrated loads. These conditions required the Mallet type, yet the decision to use it was accompanied with misgivings, because only native, and not the highest grade of labor is available for either their operation or maintenance.

The low-pressure cylinders with the three leading axles form a truck which is pivoted, by a substantial hinged joint, to the saddle casting of the high-pressure cylinders. The front end of the boiler is carried on two segmental slides, one of which is shown in the photograph.

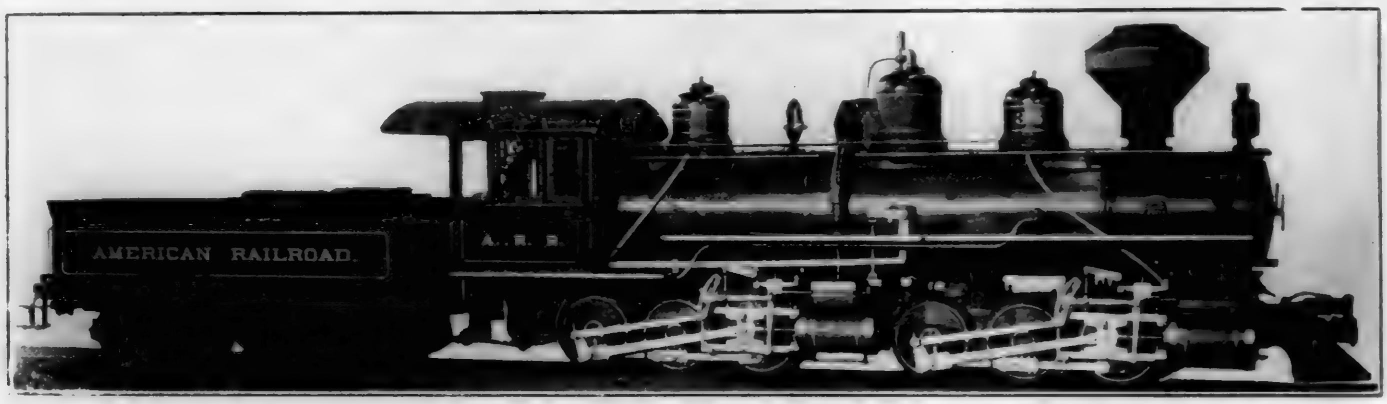
Of necessity, the Walschaert valve gear was used on these engines, and this is important in estimating the value of the Walschaert gear for standard-gauge locomotives. In this case inside gear could not possibly be used because of insufficient room. In standard-gauge locomotives there is sufficient room for the gear itself, but not sufficient space for its proper care.

These little engines are giving excellent results, as shown in reports of service, showing great economy of fuel and greater hauling power than any engines previously used on the island. If Mallet compounds will operate satisfactorily in charge of Porto Rican negroes, why should we not obtain the advantages offered by this type of construction with our enlightened people and methods?

A list of dimensions follows:

MALLET COMPOUNDS FOR PORTO RICO.

Gauge	3 ft. 3⅜ ins.
Cylinder	12½ ins. and. 19 ins. by 20 ins.
Valves	balanced
Boiler.	
Type	straight
Diameter	54 ins.
Thickness of sheets	9-16 in.
Working pressure	200 lbs.
Fuel	soft coal
Staying	radial
Fire Box.	
Material	steel
Length	95 15-16 ins.
Width	27¼ ins.
Depth, front	51 ins.
Depth, back	49 ins.
Water Space.	
Front	3½ ins.
Sides	2½ ins.
Back	2½ ins.
Tubes.	
Material	iron
Wire gauge	No. 12
Number	155
Diameter	2 ins.
Length	15 ft. 6 ins.
Heating Surface.	
Fire box	106 sq. ft.
Tubes	1,251 sq. ft.
Total	1,357 sq. ft.
Grate area	18 sq. ft.
Driving Wheels.	
Diameter of outside	37 ins.
Diameter of inside	32 ins.
Journals	6 ins. by 7 ins.
Wheel Base.	
Driving, each group	6 ft. 10 ins.
Rigid, each group	6 ft. 10 ins.
Total engine	20 ft. 4 ins.
Total engine and tender	42 ft. 8 ins.
Weight.	
On driving wheels	106,650 lbs.
Total engine	106,650 lbs.
Total engine and tender	about 156,000 lbs.
Tender.	
Wheels, number	8
Wheels, diameter	26 ins.
Journals	3¾ ins. by 7 ins.
Tank capacity	2,200 gals.



Mallet Compound Locomotive for Porto Rico—Baldwin Locomotive Works, *Builders.*

Prize Competition.—The *Engineering News* Publishing Company has instituted prizes of $250 and $100 for the best papers on the subject of the manufacture of concrete blocks and their use in building construction. Information may be obtained from *Engineering News*, 220 Broadway, New York.

90-INCH DRIVING WHEEL LATHE.

The Pere Marquette Railroad has just installed a Niles new standard 90-in. driving wheel lathe in their shops which is designed to take two cuts ½ in. deep with a 3-32-in. feed, at a cutting speed of 20 ft. per minute, thus removing about 350 lbs. of metal per hour. It has a capacity between face plates of from 6½ to 9 ft. and swings 91 ins. over the bed. The speeds are arranged for turning wheels from 50 to 84 ins. in diameter, and the wheels are taken in or out of the machine without changing the position of the carriages, it being only necessary to move the tailstock sufficiently to the rear to withdraw the crank pins from the openings in the face plates. One man can easily move the tailstock by means of the ratchet and lever, but if desired a 3-h.p. motor may be furnished for this purpose. A 30-h.p. General Electric motor with a speed range of from 400 to 800 r.p.m. is used for the main drive. The quartering attachments are each driven through Morse silent chain by a 3½-h.p. motor with a speed range of from 980 to 1,275 r.p.m.

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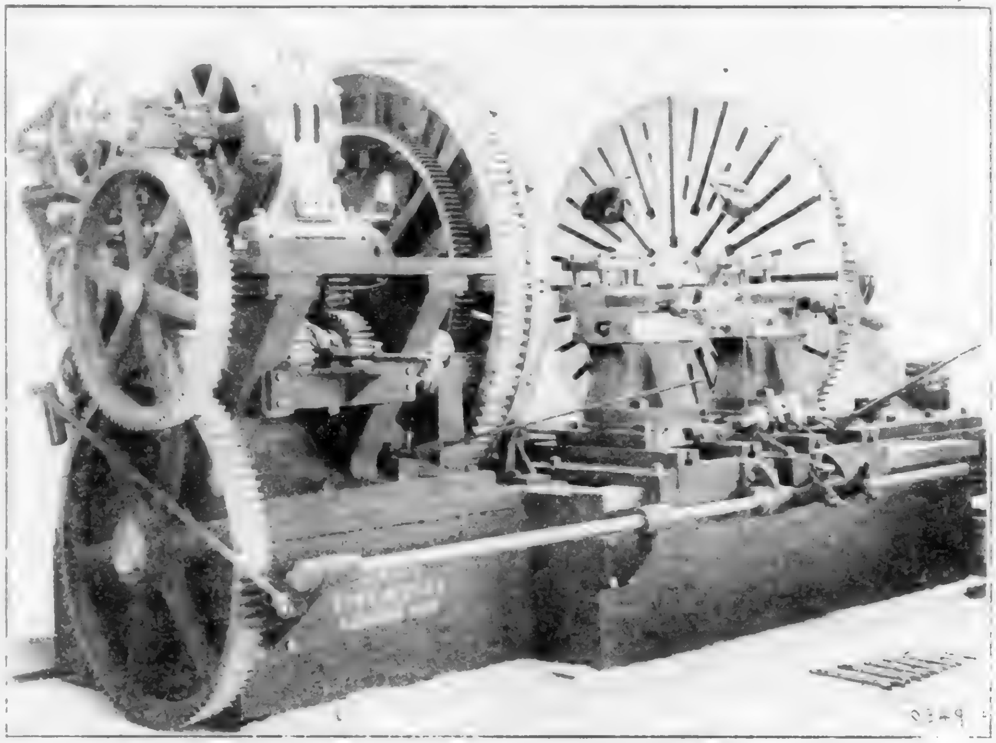
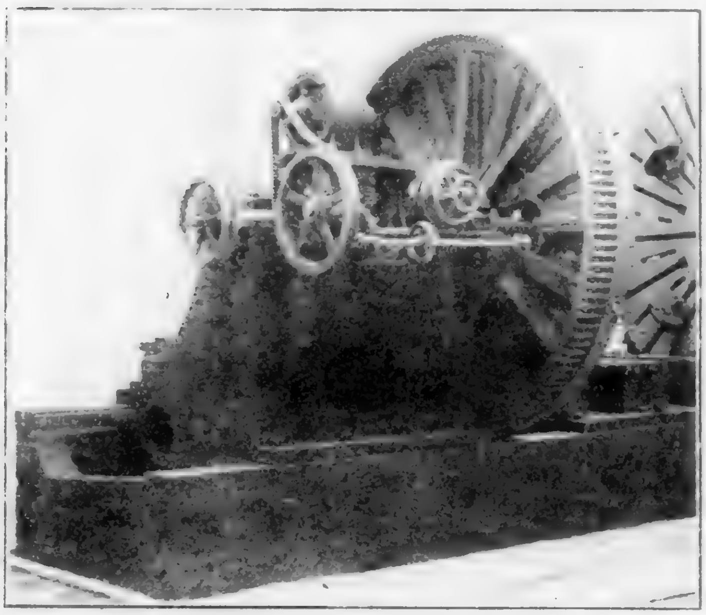


NILES 90-INCH DRIVING WHEEL LATHE—PERE MARQUETTE RAILROAD.



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If high-speed drills have shown up defects in the design of pright drills, they have made even greater trouble for the ilders of radial drills. The coarser feeds have greatly increased the upward thrust on the arm, and this and the increased twisting action, due to the saddle being on one side, have made it necessary to very greatly increase the strength of the entire machine. It is an interesting study to see how he various builders are strengthening the parts without increasing the weight of the machine to such an extent as to make it unwieldy. The columns are being made much stronger and more rigid. The arms are being designed as cantilever eams of uniform strength, with the metal distributed to the st possible advantage, thus greatly strengthening them, and n many cases considerably improving their appearance from n engineering standpoint. As a rule, positive feeds are provided, and the motor applications are much better than those n upright drills.

MALLET COMPOUND LOCOMOTIVES, AMERICAN RAILROAD, PORTO RICO.

Four of these locomotives, by the Baldwin Locomotive Works, have gone into service under particularly trying conditions. The road is crooked, the gauge 3 ft. 3⅜ ins., and the steepest grade is about 2 per cent., and the trains are of about 500 tons each. Compounds were desired because of the high cost of fuel, and the character of the track construction could not permit of highly concentrated loads. These conditions required the Mallet type, yet the decision to use it was accompanied with misgivings, because only native, and not the highest grade of labor is available for either their operation or maintenance.

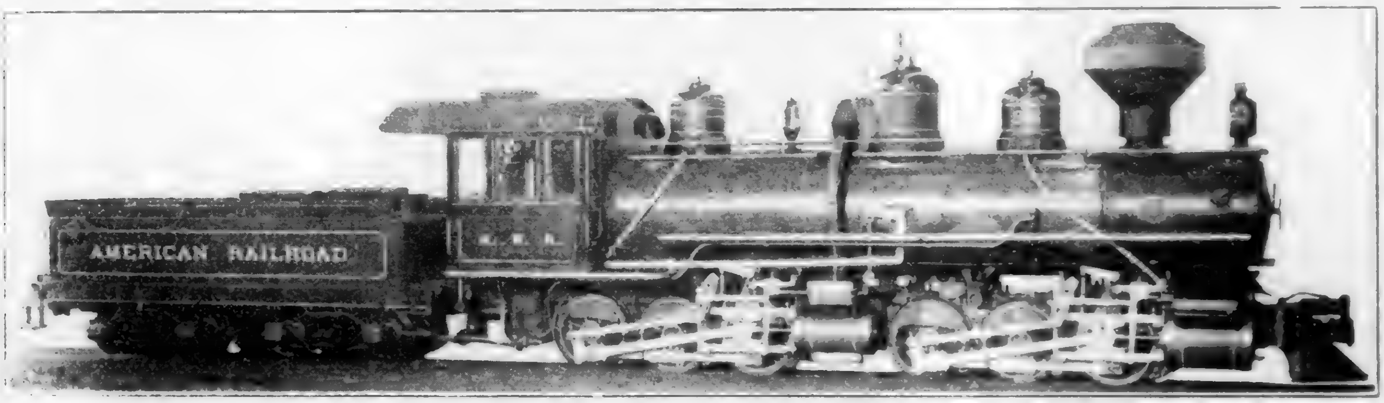
The low-pressure cylinders with the three leading axles form a truck which is pivoted, by a substantial hinged joint, the saddle casting of the high-pressure cylinders. The front end of the boiler is carried on two segmental slides, one of which is shown in the photograph.

Of necessity, the Walschaert valve gear was used on these engines, and this is important in estimating the value of the Walschaert gear for standard-gauge locomotives. In this case inside gear could not possibly be used because of insufficient room. In standard-gauge locomotives there is sufficient room for the gear itself, but not sufficient space for its proper care.

These little engines are giving excellent results, as shown in reports of service, showing great economy of fuel and greater hauling power than any engines previously used on the island. If Mallet compounds will operate satisfactorily in charge of Porto Rican negroes, why should we not obtain the advantages offered by this type of construction with our enlightened people and methods?

A list of dimensions follows:

Gauge	[illegible]
Cylinder	[illegible]
Valves	[illegible]
Boiler.	
Type	[illegible]
Diameter	54 ins.
Thickness of sheets	9-16 ins.
Working pressure	200 lbs.
Fuel	soft coal
Staying	radial



MALLET COMPOUND LOCOMOTIVE FOR PORTO RICO. BALDWIN LOCOMOTIVE WORKS, *Builders*

Fire Box.	
Material	steel
Length	95 15-16 ins.
Width	[illegible]
Depth, front	51 ins.
Depth, back	49 ins.
Water Space.	
Front	3½ ins.
Sides	2½ ins.
Back	[illegible]
Tubes.	
Material	iron
Wire gauge	No. 12
Number	155
Diameter	2 ins.
Length	15 ft. 6 ins.
Heating Surface.	
Fire box	106 sq. ft.
Tubes	1,251 sq. ft.
Total	1,357 sq. ft.
Grate area	18 sq. ft.
Driving Wheels.	
Diameter of outside	[illegible]
Diameter of inside	32 ins.
Journals	[illegible] by 7 ins.
Wheel Base.	
Driving, each group	6 ft. 10 ins.
Rigid, each group	6 ft. 10 ins.
Total engine	20 ft. 4 ins.
Total engine and tender	42 ft. 8 ins.
Weight.	
On driving wheels	106,650 lbs.
Total engine	106,650 lbs.
Total engine and tender	about 156,000 lbs.
Tender.	
Wheels, number	[illegible]
Wheels, diameter	[illegible]
Journals	3¾ ins. by 7 ins.
Tank capacity	2,200 gals.

PRIZE COMPETITION.—The *Engineering News* Publishing Company has instituted prizes of $250 and $100 for the best papers on the subject of the manufacture of concrete blocks and their use in building construction. Information may be obtained from *Engineering News*, 220 Broadway, New York.

BELTING.

The following notes are abstracted from a set of belting instructions compiled by Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, and issued for use in the shops by Mr. R. T. Shea. The time that machines are out of service due to belts being repaired or replaced is the largest item of expense in the cost of belting and its maintenance, and this is especially true if several machines must be stopped while one belt is being repaired. The most important consideration therefore in making up tables and rules for the use and care of belting is to secure a minimum of interruption to machine operation from this source.

It is desirable to locate the machinery so that the belts shall run off from each shaft in opposite directions, as this arrangement will relieve the bearings from the increased friction that would result were the belts all to pull the same way. Two shafts connected by a belt should never, if possible to avoid it, be placed one directly over the other, as in such a case the belt must be kept very tight to do the work. It is desirable that the angle of the belt with the floor should not exceed 45 deg. If possible the machinery should be so placed that the direction of the belt motion shall be from the top of the driving to the top of the driven pulley. The faces of pulleys should be about 25 per cent. wider than their belts. When practicable, belts should be tightened by moving one pulley away from the other.

The ability of a belt to transmit power depends upon the tension under which it is run, the degree of friction between the belt and the pulley, the complete contact of the belt with the pulley, the speed of the belt, and the arc of the pulley in contact with the belt. The tensile strength of single, ordinary tanned leather belting is about 4,000 lbs. per sq. in. The working strain should not exceed 10 per cent. of its tensile strength. The average leather belt will not transmit a force equal to its strength, for the reason that it will slip on its pulley before it will break.

As the friction of leather on leather is five times as great as that of leather on iron, the adhesion between the belt and the pulley can be greatly increased by covering the pulley with leather. The belt is thus capable of doing more work for a given width; the belt tension can be lessened to get the necessary friction, thus adding to the life of the belt; and unnecessary wear of the belt and a wasteful loss of power due to its slipping on the pulley are prevented. The strain to be allowed for all widths of belting—single, light double and heavy double—is in direct proportion to the thickness of the belt, firmness of the leather being the same in all cases. Avoid running belts too tight, as great tension shortens the life of the belt, occasions a waste of power and causes great inconvenience from hot boxes, broken pulleys and "sprung" shafting. Belts, like gears, have a pitch line, or a circumference of uniform motion. This circumference is within the thickness of the belt, and must be considered if pulleys vary greatly in diameter and a required speed be necessary.

Belts are more satisfactory made narrow and thick, rather than wide and thin. Thin belts should not be run at a high speed or wide belts be made thin. Such almost invariably run in waves on the slack side, or travel from side to side of the pulley, especially if the load changes suddenly. This waving and snapping wears the belts very fast; it is greatly obviated by the use of a suitable thickness in the belts. For new belts those that have already been filled with some good waterproof dressing are preferable to "dry" belts, for if not so filled they soon will be, with lubricating oil and water, a combination that will ruin any belt. Rubber belts should be used in places exposed to the weather, as they do not absorb moisture, nor so readily stretch or decay as leather belts under like circumstances. A new belt should be made straight, and if so made will run absolutely straight if the pulleys are in line. Slots punched in the center of a belt allow a chance for the air to escape between the belt and the pulley, and prevent "air cushion"; this is of a particular advantage in all belts running at high speed.

It is safe and advisable to use a double belt on a pulley 12 ins. in diameter, or larger. Light double belting runs steadily, with a minimum of "snap" or vibration, and does not twist out of place like single belting. It is successfully used for counter belts where shifters are used and where the work is not sufficiently hard to demand a heavy double belt; it is especially adapted for use on cone or flange pulleys, as it will keep its place and is less liable to turn over, and at the same time is pliable enough to hug the pulleys like a single belt. Double belting, light or heavy, is not recommended for twist belts at high speed, nor for wood work where belts are exposed to a large amount of chips or shavings, nor for places where much oil or water are liable to get on it.

As a means of making necessary alterations in the length of a belt the laced joint is recommended. To lace a belt, cut the ends perfectly true with the aid of a tri-square. Punch the holes exactly opposite each other in the two ends. The grain (hair) side of belt should be run next to the pulley, and the belt should run off, not on to the laps. For belts 1 in. to 2¼ ins. wide use ¼-in. lacing; 2½ ins. to 4½ ins. wide, use 5-16-in. lacing; 5 ins. to 12 ins. wide, use ⅜-in. lacing. For wider belts use wider lacing. Avoid thick lacing. In punching a belt for the lacing, it is desirable to use an oval punch, the longer diameter of the punch being parallel with the belt, so as to cut off as little of the leather as possible. There should be in each end of the belt two rows of holes staggered. Holes should be as small as possible. Recommended number of holes in the belt end for various widths are as follows:

Width in inches.........	2	2½	3	4	5	6	8	10	12
Number of holes.........	3	4	5	7	9	11	15	19	23

The edge of any hole should not come nearer to side of the belt than ⅝ in., nor nearer the end than ⅞ in. The second row should be at least 1¾ ins. from the end of the belt. On wide belts these distances should be even a little greater. Begin to lace in the center of belt, and take much care to keep the ends exactly in line, and to lace both the sides with equal tightness. The lacing should not be crossed on the side of the belt that runs next to the pulley.

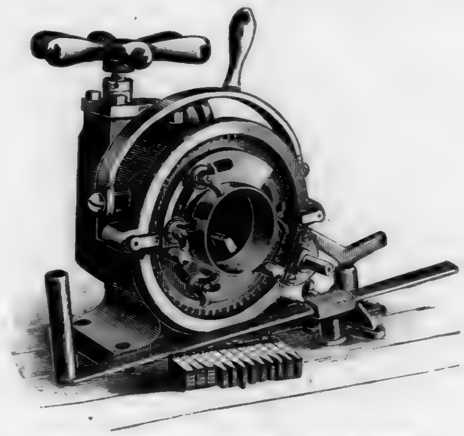
Belts and pulleys should be kept clean and free from accumulations of dust and grease, and particularly lubricating oils, some of which permanently injure the leather. They should be well protected against water, and even moisture, unless especially waterproofed. Resin should not be used to prevent belts from slipping. If a belt slips see first that the pulley is not dirty. Clean all the dirt from it and from the belt; rub the pulley surface of the belt with a dressing composed of 2 parts of tallow and 1 part of fish oil, rendered and allowed to cool before using. This will soften a belt and also preserve it, and it will not build up on the pulley and cause the belt to run to one side. If the belt then slips it is overloaded, and the remedy lies in a leather-covered pulley, a wider belt or a larger pulley.

PORTABLE PIPE CUTTING AND THREADING MACHINE.

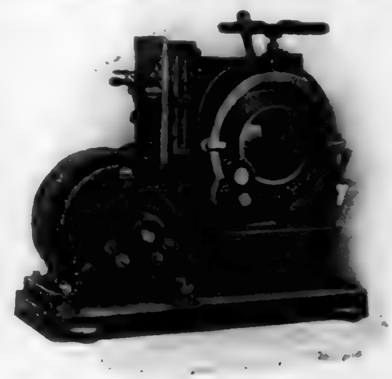
A hand die stock with its long handles is not satisfactory where it is necessary to thread several pieces of pipe at a time or for threading the larger sizes of pipe; for instance, three or four men are required to thread a piece of 4-in. pipe. It is often desirable to have a portable machine which may be operated either by power or by hand, and with which one man can easily thread the larger sizes of pipe. The machine shown in the accompanying illustrations is intended for use where it will not pay to install an expensive power machine which will have to be permanently located at one point and have all the pipe brought to it. It is portable, but by the addition of a cast iron base and the necessary gearing and countershafting it may be operated by power. If equipped for power, it may readily be taken off its base and used on outside work as a hand machine. Fig. 2 shows one of these machines driven by a Crocker-Wheeler Company 2 L motor, which has a speed variation of 2 to 1 by means of field control.

The machine consists of a die-carrying gear supported and surrounded by a shell, and driven by a small pinion imbedded in the side of the shell. The pipe is placed in the vise at the rear of the machine, with the end to be threaded against the back of the dies. The die carrying gear is then revolved by means of a crank on the end of the pinion shaft and is drawn into the shell against the end of the pipe. The dies open and are adjustable. When the thread is cut they can be opened and the pipe taken out without stopping the machine or running it back. In cutting off the pipe the large gear is shoved back in the shell, and is held by a stop, which allows it to rotate, but prevents longitudinal motion. A blade cutter is then inserted in the gear and is automatically fed against the work.

If it is necessary to cut a thread on the exposed end of the pipe, the machine can be slipped on the end and the thread cut without disconnecting it. Because of the large gear reduction, one man can easily cut a thread on any size of pipe which the machine will handle. The dies may be sharpened by grinding without drawing the temper. The shells are adjustable for wear. This machine is known as the Forbes' patent die stock, and is made by The Curtis & Curtis Company of Bridgeport, Conn., in sizes to thread pipe between ¼ and 14 ins. in diameter. Its small size permits it to be used in confined spaces.



PORTABLE PIPE THREADER AND CUTTER.



MOTOR DRIVEN PIPE THREADER AND CUTTER.

PLANER PRACTICE.

That the manufacturers of planers have not been behind in improving their machines in accordance with the recent marked advance in machine shop practice is shown by the improvements which have been made during the past year or two. The aim has been to strengthen them to take the heavy cuts with the high-speed steels, to make the operation more convenient in order to save as much of the operator's time as possible, and to improve the driving mechanism and provide for higher cutting and return speeds, and in some cases a variable cutting speed with a constant return speed. Because of the reciprocating motion and the weight of the moving parts, more especially of those revolving at a high speed, the problem has been a difficult one. That it has been successfully solved is indicated by the fact that the tool steel maker can no longer boast that machines of this type cannot be made to work to the limit of the high-speed steels.

The return stroke of the planer is unproductive, and the ideal condition would, of course, be to eliminate it entirely in point of time. The return speeds recommended by the different makers vary from 60 ft. per minute for the larger size machines to 200 ft. per minute for the smaller ones. There is, however, a considerable difference of opinion as to the maximum return speed which it is advisable to use. Several makers do not recommend higher speeds than 100 ft. per minute, because of the shock, and the large amount of power consumed at reversal, but state that they are prepared to provide higher speeds if desired. At least two makers, however, flatly recommend using a return speed of 200 ft. per minute under certain conditions, and claim that their machines may be successfully and economically operated thus. One of these recommends 200 ft. per minute for 24-inch planers and 80 ft. per minute for 120-inch machines, the speed varying proportionately for intermediate sizes. The other recommends a return speed of 200 ft. per minute when the cutting speed does not exceed 65 ft. per minute, and 150 ft. per minute with higher cutting speeds, and claims that this is entirely practical, and can be done without shock or jar at the reversal. This machine is so arranged that a high or low return speed may be obtained by simply raising or lowering a latch. This is the only planer which provides for a variation in the speed of the return stroke independently of the speed of the cutting stroke if we except those driven by the reversible motor drive described on page 31 of our January journal, which may be arranged to provide a variable return speed entirely independent of the cutting speed. The advisability of providing for more than one rate of return speed except in a case such as cited above is very questionable.

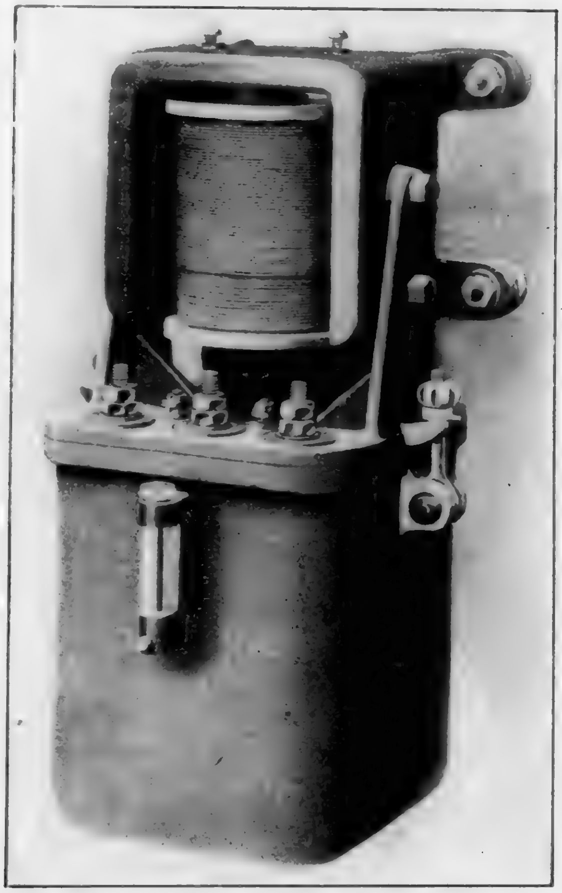
The cutting speed depends on the tool steel, the material and the nature of the work being machined and the size of the planer, for it is, of course, not advisable to operate the very large ones at a high rate of speed. In general, a roughing cut of 50 ft. per minute on cast iron is about all the tool steels will stand in planer practice. Certain grades of cast iron are being machined successfully at 70 ft. per minute, and tests have been made at much higher speeds, but it is believed that between 50 and 60 ft. per minute is as high as can successfully be used in general practice; in fact, it is higher than that usually recommended. A soft steel may be cut at higher speeds, but it is doubtful if a cutting speed higher than from 60 to 75 ft. per minute can be used to advantage on this class of work. The general opinion seems to be that finishing cuts should be taken at lower speeds, depending upon the accuracy required.

Variable cutting speeds are furnished by means of change gears, speed boxes, variable speed countershafts and variable speed motors. It is, of course, desirable to keep the return speed constant, and that the changes in speed be made with the least possible loss of time. Two or three changes of speed are all that the ordinary planer operator can use to advantage. Under the direction of a speed foreman it might be possible to use a greater number with good results.

One of the largest planer builders states that at present they are equipping about 75 per cent. of the planers over 36 ins. with motor drives, and from 25 to 30 per cent. of the smaller ones, and predicts that these percentages will be increased in the near future, due to the improvements which have been made in motors used for this purpose. Other builders report smaller percentages, but there seems to be no question as to the ability of the motors to successfully drive these machines. The planer manufacturers are watching closely the reversible motor drive, for if it proves successful, and the present indications are that it will, and is a commercial possibility, its use will greatly simplify the design of the planer itself.

ALTERNATING CURRENT SWITCHES.

With the growing use of induction motors there has been an increasing demand for a switch that may be placed at any point on a line of alternating current distribution and be operated from some distant point selected as the center of control. Heretofore it has been necessary where independent control was desirable to carry independent circuits of heavy wire, double or triple according to the phase, from the power house or central point of control to the various motors, transformers and other apparatus. The electrically operated switch illustrated in the photograph is designed to do away with this costly wiring. The design of the switch is such as to take advantage of the peculiarities of the alternating current solenoid, at the same time combining simple construction and a small size solenoid with positive and reliable action. The solenoid is actuated by a push button or small snap switch, which may be located at any distance from the point where the switch is installed.



SOLENOID SWITCH FOR ALTERNATING CURRENT.

An important application of this switch is in connection with auto starters or grid resistance starters for the operation of motors of large size used in connection with ventilating systems, plunger elevator systems, pneumatic tool equipment, or wherever it is desirable either to stop and start a motor from some distant point or automatically control it. Another important field for this apparatus is the throwing in and out of one or more transformers where there are several in a bank operating through certain hours of the day to their full capacity, but during the longer periods running on such light loads as to be very inefficient if they were all left in circuit. A solenoid switch placed in the circuit of each transformer enables the operator at the station to throw out as many as the load conditions warrant, or they may be arranged to operate entirely automatically as the load rises or falls. One or more of these switches may be used in central stations as synchronizers, as they work simultaneously from the switchboard regardless of the location of the switches. They may also be used to advantage in connection with traveling cranes, turn-tables, ventilating systems and cistern pumps operated by induction motors.

As the solenoid is in circuit only while the switch is closed, the current used is negligible, and the efficiency is high when compared with the line losses on independent power circuits. The apparatus is mounted on a slate panel which may readily be secured to any support; it is equipped with overload and underload safety devices, and has an oil gauge, which enables the attendant to see that the oil is at the proper level in the tank. The apparatus may be used where gas or combustible particles make it dangerous to have any sparking or arcing. The hermetically sealed type is proof against acid or other fumes which would corrode or disintegrate the parts. These switches are made by the American Electric & Controller Company, who have recently engaged etxensively in the manufacture of alternating current apparatus, in addition to their direct current work.

THE CARE OF PNEUMATIC TOOLS.

The following extract is taken from an article in *The Engineering Magazine* on "Systematization and Tool-Room Practice in Railway Repair Shops," by Mr. R. Emerson:

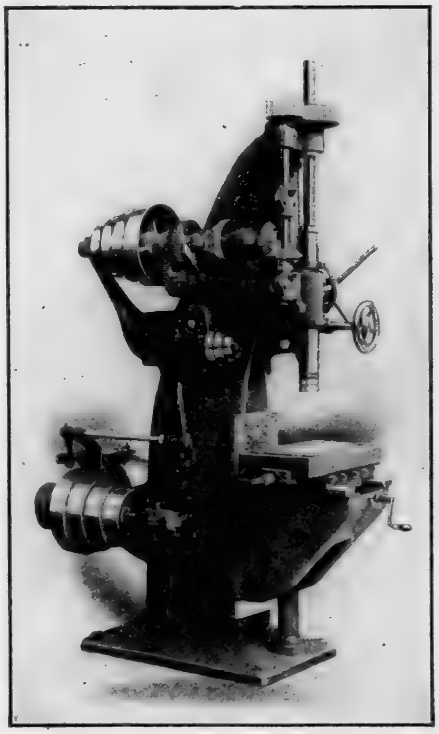
Railroads use tools of all kinds; it is difficult to say whether the investment in small tools or in machine tools is greater. While the former are individually cheaper, they may be collectively more costly. One of the most important features of small-tool equipment is the air-tool service. These tools for the money invested in them do giant's work, but on account of the severe strains to which they are put they suffer frequent disorders. Unless this branch of the service is rigorously supervised, constant trouble and vexatious delays will result. From figures in my possession, I find that the maintenance and repair charges on pneumatic tools range from 60 per cent. to 90 per cent. per annum on the purchase price of these tools, without counting the depreciation and interest charges, which in the case of tools with life so short as these are very high—I should say, combined, an additional 100 per cent. In fact, this maintenance and repair cost, together with the purchase price of the tool, will average somewhat above $200 per annum, this figure applying equally to motors and hammers. As it is false economy to do work by hand that can be done by air, and as there is much work that can be done more conveniently and cheaply with portable air tools than with stationary machine tools, the larger the number of air tools engaged in productive work the cheaper the output costs.

One large railroad company had its pneumatic-tool account rising steadily for the past five years, averaging over $15,000 per year for new tools and material and labor repair charges alone. This account had not been systematically looked after, tools being battered around the shop till it was no longer possible to effect simple repairs and adjustments, when they were sent to the manufacturers for thorough overhauling and replacement of parts. The practice obtained of men seizing what motors they could lay hands on and using them, often carelessly, until the machines would no longer give good service or run at all. There was practically no one to raise the question except the man using the machine or the shop foreman who was interested in the output of the work, or the tool-maker who was delegated to make repairs—each of these men being powerless to effect any reform or establish any system or incite any interest in the matter of properly handling these tools as a general proposition. But when the master mechanic himself awoke to the importance of this matter—because, on the one hand, of the curtailment of his requisitions for additional air-tool equipment, and because, on the other hand, of a long-drawn howl on the part of the shops for increased facilities in this direction—he set a special apprentice to work to see what could be done and saved by means of an efficient system. The net result of a system of holding men and foremen responsible for machines definitely assigned to their charge, together with the enthusiastic co-operation and

...enious handling of the repair question by the tool-room ... man, was a reduction in cost to less than $5,000 per year, ... counting interest, depreciation, and fixed charges. This ...ng represents the interest at 4 per cent. on $250,000. ...se figures take no account of the saving of the men's time ... to increased use of air-tool equipment and more efficient ...rformance of same in service, as these savings, being indi...t, though great, could not be determined.

HIGH-SPEED VERTICAL DRILL.

The drill press shown in the accompanying illustration has ...n especially designed to withstand the heavy feeds and the



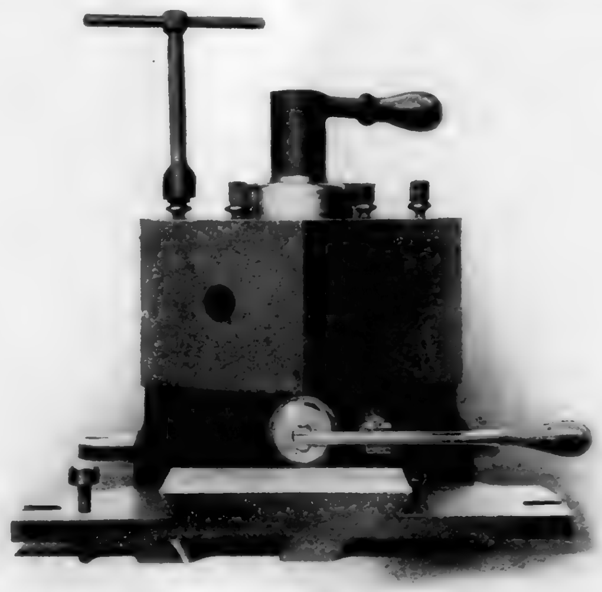
NEW HIGH-SPEED DRILL.

high speeds that can be used with high-speed drills. It has a speed range of from 45 to 500 r.p.m., and is adapted for drills from ⅝ to 1½ ins. in diameter. It is equipped with a compound table, having screw adjustments in all directions, so that the work, when clamped, may be quickly and accurately centered on the drill or reamer. This arrangement has several advantages over the ordinary type of swinging table. It allows the column to be designed to much better advantage, and the connection between the column and the table may be made much more rigid, thus making it possible to do accurate work and at the same time use the heavy feeds with high-speed drills. It also obviates the difficulty experienced with the swinging table due to the split clamp getting out of alignment, thus causing work, when accurately centered, to draw away from the drill when the clamp is tightened up. By means of micrometers, which are provided, the holes may be accurately spaced without previously laying them out. This drill is made by Baker Bros., of Toledo, O.

Turbines vs. Reciprocating Engines.—A striking example of the difference in size, weight and speed between turbine and reciprocating engines of the same capacity may be seen in the power equipment of the Rapid Transit Company in New York. Turbine type generators with a rated output of 5,000 kw., weighing 234,000 lbs., run at 750 r.p.m. Generators of the same output driven by reciprocating engines at a speed of 75 r.p.m., weigh 980,000 lbs. Orders for 8 turbine generators have been placed with the Westinghouse Electric & Manufacturing Company in the past few days, mostly for 400 and ...00 k.w. units, with one 2,000 k.w. and one 2,500 k.w. machine.

NEW TURRET FOR LATHE CARRIAGE.

The turret for a lathe carriage, shown in the accompanying illustration, is interchangeable with the regular compound rest, and is designed to have a stiffness and rigidity commensurate with the increase in power required by the new tool steels. The principal departure from the ordinary standard is in the plate on which the cross slide moves. This is made to slide onto the regular carriage dovetail, and is secured in place by four bolts in the tee slot of the carriage wings. The cross slide is made with a bearing about twice as wide as that of the compound rest. The plate is slotted, permitting the cross-feed nut to extend up and attach to the cross slide, so that the cross feed may be applied to the turret. As no movement of the plate takes place, the regular carriage dove tail is relieved of all wear. This turret was designed by the Lodge



NEW TURRET FOR LATHE CARRIAGE.

& Shipley Machine Tool Company to meet the growing demand for such a device.

SMASHING MACHINE TOOLS.

A large manufacturing concern whose shops are filled with modern "up-to-date" machine tools, complains that in order to utilize the high speed steels to full advantage, machine tools are often broken. We were not surprised at this when we found cast steel being planed with a ½-in. feed and a depth of cut as great as ¾ in. in places. It is claimed by those in charge that there is great economy in working the machine tools at this rate in spite of the expense and inconvenience caused by breakages. Machine tools will have to be made still stronger to stand this kind of service. How can those in charge of our railroad shops justify their course of very carefully handling tools from 10 to 50 years old in order to make them last a little longer? The operators' wages are the largest item in the cost of turning out work and surely if shop managers would study the question from this standpoint old machine tools would be scrapped and efforts would be concentrated to increase the output of each machine in order to reduce the labor charge per piece to a minimum.

Scrapping Old Machines.—It may be stated as a general proposition that if a new machine be invented which will, by increasing the output only 10 per cent., reduce the cost an equal amount, it pays to scrap the old machine.—*Mr. Alexander E. Outerbridge, Jr., Am. Academy of Political and Social Science.*

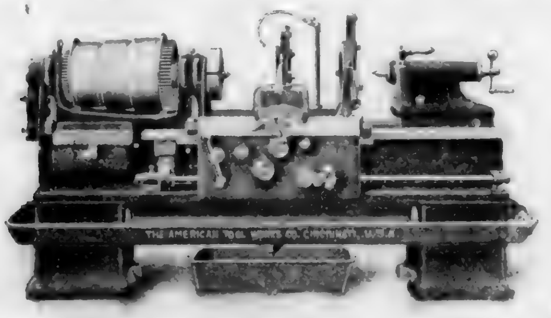


FIG. 1—18-IN. HIGH-SPEED MANUFACTURING LATHE.

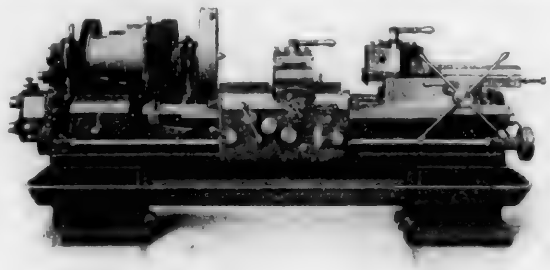


FIG. 3—20-IN. LATHE WITH FRICTION HEAD AND TURRET.

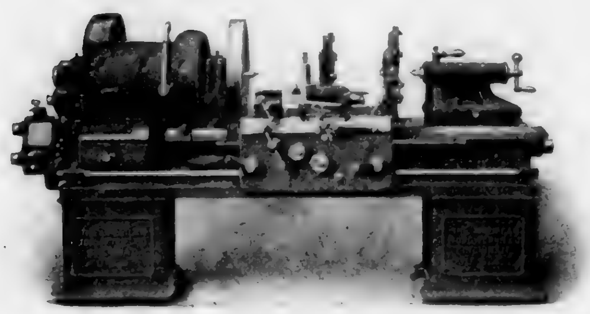


FIG. 2—20-IN. LATHE WITH ALL GEAR HEAD.

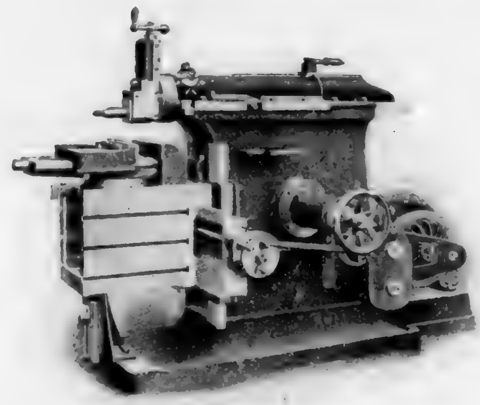


FIG. 5—24-IN. MOTOR DRIVEN SHAPER.

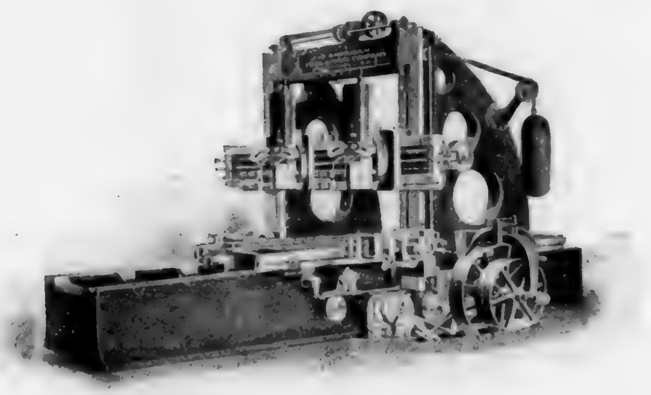


FIG. 4—48 BY 48-IN. PLANER.

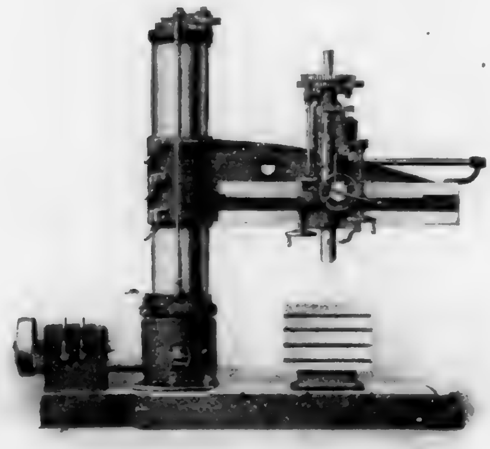


FIG. 6—4-FT. RADIAL DRILL.

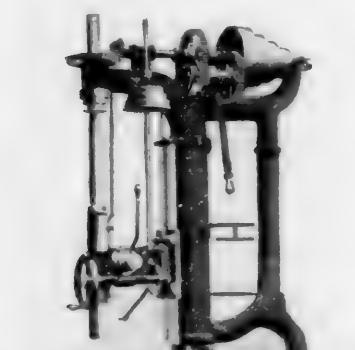


FIG. 7—25-IN. STANDARD DRILL.

A LINE OF MODERN MACHINE TOOLS.

Machine shop methods have advanced so rapidly during th past few years that the machine tool builders have not onl found it necessary to completely redesign their line of tool but from time to time have had to make radical changes in th new designs in order to keep up with the most advanced sho practice. The accompanying illustrations show some of th more recently designed machine tools made by The America Tool Works Company.

The 18-in. high speed manufacturing lathe shown in Fig. is specially designed for the use of high-speed tools, and wi maintain a continuous cutting speed of from 150 to 200 f per minute, depending on the nature of the material, on wor from 1 to 4 ins. in diameter. It is driven by a 4-in. doubl belt, and this, with the large diameter of all three steps the cone pulley, makes a very powerful drive. The desig throughout is very strong and substantial, so that the limit o the work is at the tool rather than at the belt. Geared feed are provided, which may easily be changed by means of th

...le under the headstock. A plentiful supply of water is ...d on the cutting tool through the flexible tube.

... lathe shown in Fig. 2 has an all gear headstock, which ...mple and efficient, and in addition to greatly increasing ... power of the lathe and affording a quick and convenient ...od of changing the speeds, the expense of changing will ...very small if at any time it is desired to change from a ... to a motor drive. Six steel cut gears, which have wide ...s and coarse pitch, furnish four speed changes, and are ...rated by the two levers at the front of the head. These ...s are completely housed in, thoroughly lubricated, and ... at low pitch line velocities, thus reducing the noise to ...minimum.

The lathe shown in Fig. 3 is equipped with a friction head, ...d has a turret mounted on the shears. The friction back ...ar may be thrown in or out of service instantly by shifting the lever at the front of the head. This feature is especially valuable in handling work requiring frequent interchange between the fast and slow speeds. The turret is equipped with power feed and, if desired, it may be placed on the carriage instead of on the shears, or be made round instead of hexagonal.

The heavy pattern 48-in. planer with four heads, illustrated in Fig. 4, is equipped with an improved shifting mechanism, which prevents the shrieking of the belts and reverses the table without shock or jar. The heads on the cross rail are made right and left, in order to permit of planing close together. The design throughout is such that the planer may be operated at comparatively high cutting and return speeds, and full advantage may be taken of the high-speed steels.

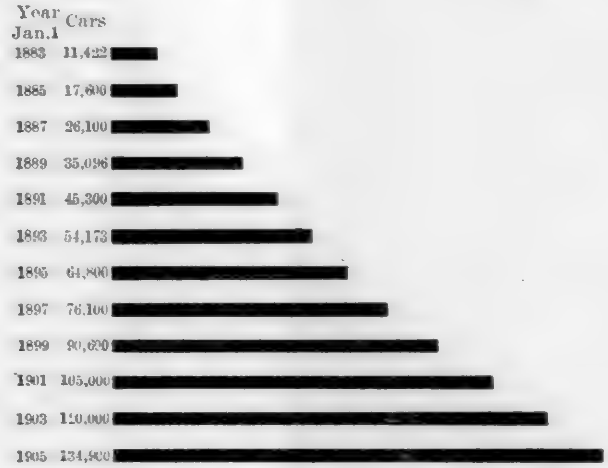
Fig. 5 illustrates a back geared crank shaper driven by a constant speed motor mounted on an extension of the base and connected by spur gears to the driving shaft of the speed box, which furnishes four speed changes. The back gear ratio is 24.3 to 1, thus allowing exceptionally heavy cuts to be taken. The design of the rocker arm and column is such that a 3¼-in. shaft may be passed under the ram for key-seating. The machine has been carefully designed, with a view to rapidly chucking and machining all classes of work, usually handled on this type of tool.

The 4-ft. radial drill shown in Fig. 6, which holds the record for rapid drilling, is of unusually heavy design, and is well adapted for the use of high-speed drills. It has a depth gauge and a trip which acts automatically at the full depth of the spindle, preventing breakage of the feed mechanism. The speed box of the geared friction type furnishes four changes of speed by means of the two levers; the spindle has sixteen changes of speed, arranged in geometrical progression from 16 to 267 r.p.m. The column is of the double tubular type, and the arm is of a parabolic beam and tube section, which gives the greatest resistance to the bending and torsional strains. A tapping mechanism is carried on the head.

The column of the 25-in. upright drill press shown in Fig. 7 is of large diameter, and is firmly braced at the back, thus giving the drill exceptional solidity and stiffness. The spindle has a patent quick return, and the automatic stop to the down feed is set by graduation on the spindle and is readily adjusted.

PROGRESS IN PINTSCH CAR LIGHTING.

The carefully kept statistics of the Julius Pintsch Company, of Berlin, showing progress in the application of gas for car lighting, are always interesting. At the present time 134,855 cars, 6,191 locomotives and 1,516 buoys and beacons are equipped with this system of lighting; in conjunction with which 364 special gas works have been equipped to manufacture and compress the gas. During the year 1904 3,084 cars and 60 buoys and beacons have been equipped in the United States and Canada with the Pintsch lighting system, 1,624 cars having been equipped with the Safety Car Heating and Lighting Company's standard system of steam heating. Pintsch lighting has been adopted by over 200 railroads of the United States, Canada and Mexico, where it has been applied to 25,000 cars and 450 buoys and beacons. The steam heating systems of this company have been adopted by over 150 railroads in the United States and applied to 16,000 cars. The simplicity of operation and the economy of maintenance

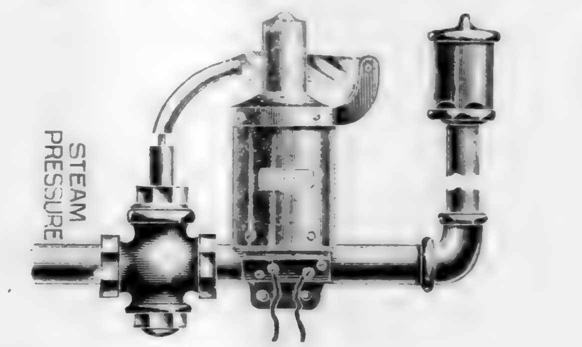


PROGRESS IN PINTSCH GAS LIGHTING.

of this system has caused it to be adopted as standard by a majority of the railroads and lighthouse departments of the world. A graphic illustration of the progress of Pintsch lighting is presented in the accompanying diagram.

ELECTRICALLY OPERATED WHISTLE VALVE.

This is a device whereby an air or steam signal whistle may be operated at any distance, by the pressure of a button located at any desired point. In a large shop or yard such a device is invaluable in calling foremen to the telephone. The engraving illustrates the standard type for all ordinary pressures of steam. Any voltage of either direct or alternating current may be provided for in the winding of the actuating solenoid. Any whistle up to 3-in. diameter may



ELECTRICALLY OPERATED WHISTLE VALVE.

be operated at pressures of from 75 to 150 lbs., and when provided with a larger valve, 6-in. whistles may be operated. The action of the solenoid is to draw down the iron cone and press down the curved lever, which opens a small pilot valve under the main valve, admitting steam to the expansion chamber above. The main valve is balanced, and further motion of the lever opens it, operating the whistle. A spring seats the pilot valve when the current is turned off, and another spring raises the solenoid plunger when out of action. The device may be used with the Churcher alternating rectifier, which converts alternating into direct current of any required voltage. At the Wilmington shops of the Pennsylvania Railroad eight of these whistles are used in the fire alarm system. At the works of the Lodge & Shipley Machine Tool Company, Cincinnati, O., a whistle has been in use nearly two

years, and enables the office to signal any of the foremen or engineers, thus saving a great deal of time in finding them. It is used in connection with their private telephone system. Further information may be obtained from the Churcher Electric & Manufacturing Company, Cincinnati, O.

FALLS HOLLOW STAYBOLTS.—A large order for this iron has been received from the Western Australian Government Railways and also from the Cuba Company for an important railroad in Cuba.

BOOK NOTES.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—A souvenir book giving the history of the organization, with photographs of past presidents, has been received from Mr. J. C. Beardsley, secretary of the club.

Ferric and Heliographic Processes; a Handbook for Photographers, Draftsmen and Sun Printers. By George E. Brown. Published by Tennant & Ward, 287 Fourth avenue, New York. 1905. Price, $1.

This little book of 150 pages is devoted entirely to methods of reproducing drawings from tracings. It presents the subject comprehensively, and includes complete descriptions and examples of various sun printing methods. It is surprising to find that there are so many good processes.

Transactions of the American Society of Mechanical Engineers. Vol. xxv, 1904. Report of the 48th and 49th meetings of the Society. 1,155 pages. Published by the Society from the Library Building, 12 West Thirty-first street, New York City.

Among the papers of special interest to our readers are: "What Are the New Machine Tools to Be," by John E. Sweet; "Road Tests of Consolidation Freight Locomotives," by E. A. Hitchcock; "Testing Locomotives in England," presented by the Institution of Mechanical Engineers; "Experiments with a Lathe-Tool Dynamometer," by J. T. Nicholson, and "Locomotive Testing Plants," by W. F. M. Goss.

Webster's International Dictionary. Published by G. & C. Merriam Company, Springfield, Mass. Price, $10.75.

This is a new and enlarged edition, printed from new plates, and contains a supplement of 25,000 additional words, a completely revised gazeteer of the world, a completely revised biographical dictionary and other improved and enlarged departments. It is impossible to "review" such a work. It is sufficient to state that in the office or the library this new edition is indispensable to those who desire to use the English language correctly. In the publication office of this journal the gazeteer alone is worth many times the price of the work. It is a truly International dictionary, and yet has not lost any of its value as an American dictionary. The words are easily found, the pronunciations are given, the meaning is clearly stated, and the growth of words is traced. It is a wealth of words, and is especially strong in scientific terms, the lack of which has been a weakness in previous works of the kind.

Elements of Mechanics: Forty Lessons for Beginners in Engineering. By Mansfield Merriman, Professor of Civil Engineering, Lehigh University. 172 pages, illustrated. Puplished by John Wiley & Sons, 43 East 19th street, New York. Price, $1.

This work presents the subject of mechanics in an elementary way. The work is closely associated with experience "by which alone the laws of mechanics can be established." It contains many numerical illustrations and problems, as exercises for the student. The author of this work believes it to be necessary to divide mechanics into two courses, one being elementary for the freshman year and the other advanced, after completing calculus. He believes the principles and fundamental methods to be vitally necessary and the present work deals with the subject without higher mathematics. Knowledge of calculus is indispensable to a complete knowledge of mechanics, but as most students wait for the calculus before taking up the subject seriously many who might understand the principles miss mechanics altogether. Professor Merriman intends this book for manual training schools and freshman classes in engineering colleges, this to form a foundation for an advanced course later on. The book meets a definite need and it carries out the idea of the author admirably.

PERSONALS.

Mr. W. S. Murrian has been appointed master mechanic of the Southern Railway at Spencer, N. C.

Mr. J. T. Stafford has been appointed assistant master mechanic of the Pere Marquette Railway at Grand Rapids, Mi

Mr. W. F. Kaderly has been appointed master mechanic of the Southern Railway, with headquarters at Alexandria, Va.

Mr. E. S. Fitzsimmons has been appointed general mas boiler maker of the Erie Railroad, with headquarters Meadville, Pa.

Mr. W. D. Lowry has been appointed master car builder the Cincinnati, Hamilton & Dayton, with headquarters Lima, O.

Mr. F. A. Delano has been elected president of the Wabash Pittsburg Terminal, to succeed Mr. Joseph Ramsey, Jr., resigned.

Mr. J. F. Fleischer has been appointed master mechanic of the Chicago & Northwestern, with headquarters at Sioux City, Iowa.

Mr. H. B. Sutton has been appointed master mechanic of the Newton & Northwestern Railroad at Boone, Ia., to succeed Mr. L. L. Collier.

Mr. C. H. Weaver has been appointed supervisor of air brakes of the Lake Shore & Michigan Southern, with headquarters in Cleveland.

Mr. Thomas Marshall has been appointed master mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railway, with offices at St. Paul, Minn.

Mr. G. A. Gallagher has been appointed master mechanic of the Illinois Southern Railroad, with headquarters at Sparta, Ill., to succeed Mr. R. J. Farrell, resigned.

Mr. J. F. Sheahan has been appointed master mechanic of the Southern Railway at Atlanta, Ga., having been transferred from Spencer, N. C.

Mr. J. T. Robinson has been appointed acting master mechanic of the Seaboard Air Line at Savannah, Ga., to succeed Mr. A. J. Poole, transferred.

Mr. W. S. Murray has been appointed electrical engineer of the New York, New Haven & Hartford Railroad, with headquarters at New Haven, Conn.

Mr. W. J. Hoskins has been appointed master mechanic of the Chicago & Eastern Illinois Railway at Danville, Ill.

Mr. F. H. Weatherby has been appointed master mechanic of the Tacoma Eastern, with office at Bismarck, Wash., to succeed Mr. Robert Bagley.

Mr. John H. Fulmer has been appointed master mechanic of the Schuylkill Division of the Pennsylvania Railroad, with headquarters at Mt. Carbon, Pa.

Mr. H. H. Maxfield has been promoted from the position of assistant engineer of motive power of the Pennsylvania Railroad at Jersey City to that of master mechanic at Trenton, N. J.

Mr. E. D. Andrews has been promoted from the position of road foreman of the Chicago, Rock Island & Pacific at Shawnee, Oklahoma, to that of master mechanic, with headquarters at Dalhart, Texas.

Mr. S. M. Dolan, master mechanic of the Southern Railway, has been transferred from Atlanta, Ga., to St. Louis, Mo.

Mr. S. C. Graham has been appointed master mechanic of the Chicago & Northwestern, with headquarters at Kaukauna, Wis., being transferred from Lake City.

Mr. O. J. Kelley, master mechanic of the Baltimore & Ohio, has been transferred from Parkersburg, W. Va., to Grafton, W. V., to succeed Mr. W. S. Galloway, promoted.

Mr. R. E. Smith, assistant to the general manager of the Atlantic Coast Line, has been appointed general superintendent of motive power, with headquarters at Wilmington, N. C.

Mr. W. F. Dasch has been appointed master mechanic of the Annapolis, Washington & Baltimore Railway, with headquarters at Annapolis, Md., succeeding Mr. J. L. Beall, resigned.

Mr. P. S. Hursh has been appointed general boiler inspector of the New York, New Haven & Hartford Railroad, with head quarters at New Haven, Conn., succeeding Mr. E. S. Fitzsimmons.

Mr. Charles W. Allen has been appointed assistant to the superintendent of motive power of the Philadelphia & Reading, with headquarters at Reading, Pa. He will have charge of the shops of the road.

NEW CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

ALTERNATING CURRENT SOLENOID SWITCHES.—Bulletin No. 3 from the American Electric & Controller Company, New York City.

SUPPLIES AND CAR SPECIALTIES.—Catalog No. 153 from the J. G. Brill Company, Philadelphia, Pa., describes the various specialties made by them.

DRILL GRINDERS.—Catalog No. 90 from Wilmarth & Morman Company, Grand Rapids, Mich., describes the various styles of the "New Yankee" drill grinder.

SMALL BELTED MOTORS AND GENERATORS.—Bulletin 51 from the Crocker-Wheeler Company, Ampere, N. J., describes their form F machines and illustrates several typical applications.

JACKASS POWER.—A small pamphlet from the Lucas Machine Tool Company, Cleveland, O., which pointedly emphasizes the advantages of their power forcing press.

FAN MOTORS.—Two folders from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., describing their desk and wall types of fan motors, for direct and alternating current circuits.

MACHINE TOOLS.—A large, loose leaf catalog from The American Tool Works Company, Cincinnati, O., describing their complete line of machine tools, which includes lathes, shapers, planers and vertical and radial drills.

CRANE SEPARATORS.—The Crane Company, Chicago, have issued an advance circular describing their steam and oil separators made in sizes from 1 to 30 ins., and in horizontal, vertical, angle and distributing types. Copies may be had by asking for "Advance Circular No. 01."

JACKS.—This is the title of a 24-page pamphlet by the Buda Foundry and Manufacturing Company, of Chicago, illustrating their ratchet, friction and ball-bearing jacks for track, bridge, locomotive and car works. Lists of repair parts and information concerning size, weight and capacity of each style are included.

PLANER DRIVES.—Bulletin No. 47 from the Northern Electrical Manufacturing Company, Madison, Wis., contains a reprint of two articles by Mr. J. C. Steen on tests of motor-driven planers which appeared in the August and September, 1904, issues of this journal. The bulletin is illustrated with several applications of Northern motors to planers.

PORTABLE TOOLS.—The various portable tools for railway repair shops made by H. B. Underwood & Co., Philadelphia, Pa., are very completely described in their 1905 catalogs.

FALLS HOLLOW STAY BOLT COMPANY.—Under the heading of "Irrefutable Evidence," this company has issued a 32-page pamphlet concerning their staybolts and staybolt material. It opens with an introductory chapter describing the material and stating its use. This is followed by observations by Mr. John Livingston and by 15 pages of reports of experience and tests of hollow staybolts on a large number of railroads. A list of 77 railroads are enumerated in a partial list of customers. The second part of the pamphlet contains similar letters and reports from leading marine and stationary boiler manufacturers. This company has gone into the subject of staybolt iron exhaustively and has accumulated valuable information. Copies of this pamphlet will be sent to any railroad man making application for it.

CAREY'S ROOFING PRODUCTS.—The Philip Carey Manufacturing Company, Lockland, Cincinnati, Ohio, have issued a number of illustrated pamphlets describing their specialties. One is devoted to 85 per cent. magnesia locomotive lagging for locomotive boilers. This pamphlet contains a number of excellent engravings of well known locomotives and discusses the merits of magnesia lagging for protecting the boilers. It also deals with its use for steam pipe coverings. Two other pamphlets on magnesia illustrate its application to steam pipes and boilers and includes a number of asbestos packing specialties. A larger pamphlet entitled "Carey's Magnesia" contains illustrations showing the application of this pipe covering in some of the best known power stations and buildings in the country, including such buildings as the St. Regis Hotel, New York City, and ships of the United States Navy. The Carey roofing is described in another pamphlet, which illustrates its method of application and discusses its merits and fireproof qualities. An additional pamphlet contains testimonials from individuals, firms and corporations using the Carey products.

NOTES.

MAGNUS METAL COMPANY.—This Company has moved its executive offices to Suite No. 1014, Trinity Building, No. 111 Broadway, New York.

AMERICAN LOCOMOTIVE COMPANY.—This company has removed its offices from the Broad Exchange Building to the Trinity Building, 111 Broadway, New York, where they will occupy an entire floor.

LOCOMOTIVE APPLIANCE COMPANY.—New offices of this company have been established in Suite 400, Old Colony Building, Chicago, where correspondence should be addressed. A cordial invitation is extended for friends to call "early and often."

The American Nut & Bolt Fastener Company have removed their general offices to their new factory, corner of Ridge avenue and Rebecca street, Allegheny, Pa., where they have increased their output to five times its amount when in the old quarters. The plant is equipped with new and modern machinery built specially for the manufacture of the Bartley fastener. This company reports that their books are filled with orders.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.—The South Side Elevated Railway Company of Chicago has contracted with this company for complete equipments for seventy cars, which includes multiple control apparatus and one hundred and forty 75-h.p. motors. The motors are of special design, and are in line with the re-equipment of this system. The cars will be operated in trains of five, three of which will be motor cars.

CROCKER-WHEELER COMPANY.—Mr. A. C. Bunker, formerly connected with the Stanley Electric Manufacturing Company, and Mr. W. C. Appleton, formerly with the General Electric Company, have become associated with the engineering and contract departments, respectively. Both of these gentlemen are alternating current engineers, and have been added to the force to take care of the rapidly increasing business in this line.

ADREON & COMPANY.—This company announces that they have secured exclusive selling rights, covering the railroads of the United States, for "Anti-Selenite Boiler Scale Solvent." This is a vegetable compound manufactured in Monterrey, Mexico. It is claimed to be remarkably effective in removing scale under all conditions and to protect the metal of the boilers. This solvent received a gold medal at the Louisiana Exposition. Further information may be obtained from Adreon & Company, Security Building, St. Louis, Mo.

DIAMOND CHAIN & MANUFACTURING COMPANY.—Mr. L. D. Bolton, heretofore Chicago representative of the Federal Manufacturing Company, is now with the Diamond Chain & Manufacturing Company of Indianapolis, and will represent that company in the Middle and Western States.

WELLMAN-SEAVER-MORGAN COMPANY.—Mr. Geo. B. Damon, manager of the New York office, has been transferred to an important position in the engineering and sales department at Cleveland. Mr. W. A. Stadelman, formerly of the Brown Hoisting Machinery Company, has succeeded Mr. Damon as manager of the New York office at 42 Broadway.

THE NILES-BEMENT-POND CO.—This company has leased an entire floor in the new Trinity Building, at 111 Broadway, New York, and will be located there after May 1st. The executive offices have been located in New York since the organization of the company under its present title. The Niles-Bement-Pond Company employs about 5,000 workmen, and has two factories in Philadelphia, one in Hamilton, Ont.; one in Plainfield, N. J., and it also owns the Pratt & Whitney Company at Hartford, Conn., thus constituting this company the largest builder of iron-working machinery in the world.

AMERICAN WATER SOFTENER COMPANY.—This company, of Philadelphia, Pa., reports that the Norfolk & Western Railway has just placed with them an order for a water softening plant having a capacity of 250,000 gallons per day, for the roundhouse at Columbus, O. This is to replace a 100,000-gallon per day plant installed a year ago, but which is too small for the present requirements. The company also reports that installations of the Bruun-Lowener water softener have been made on railroads in the United States, Argentine Republic, Chile, Spain, Denmark, Sweden and Russia, while the installation among industrial plants covers practically every country on the globe.

NOVEL INDUSTRIAL BENEFICIAL ASSOCIATION.—The shop employees of the Crocker-Wheeler Company have organized a beneficial association. Every employee who pays 10 cents a week to the association will be entitled to $10 a week for 20 weeks during incapacity through illness. If he dies, his family will receive $100. The payment of 20, 30 or 40 cents a week entitles him to $15, $20 or $25 respectively, with death benefits of $150, $200 or $250. The company contributes an amount equal to the dues paid to the association. Thus, if $6,000 are paid yearly in dues, the income of the association will be $12,000. The company does not require representation in the association, which will be run entirely by the employees.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. J. W. Duntley, the president of this company, sailed for Europe April 18th, taking five styles and sizes of electric drills for the trade of the Consolidated Pneumatic Tool Company, an important demand having developed for this class of tools. Tests will be made to demonstrate their performance. The business of the Chicago Pneumatic Tool Company is better than it has ever been. The month of March last was the best month since May, 1903. In April, up to and including the 18th, the increase in the number of tools sold over corresponding days of the month of March was 49 per cent., and an increase of 222 per cent. over corresponding days of April, 1904. Foreign business has also increased. Altogether, the present year seems likely to be the best in the history of the pneumatic tool business.

STURTEVANT GENERATING SETS.—The rapid advance of the B. F. Sturtevant Company, Boston, Mass., in the electrical field has been noticeable, and is practically marked at this time by the issue of their Bulletin No. 63, showing various types and sizes of generating sets. These range from 3 to 100 k.w., the smallest size being driven by a 3½ x 3 vertical engine, and the largest by a 14 x 14 horizontal center-crank engine. A separate series, ranging from 7½ to 100 k.w., is equipped with vertical compound engines. All the types of Sturtevant engines illustrated are completely inclosed and arranged with watershed partitions, to prevent the water from the piston rod stuffing box reaching the interior of the frame. All interior bearings are supplied with oil under a system of forced lubrication, thereby securing a mechanical efficiency considerably in excess of 90 per cent. Many of these generating sets in the vertical simple and compound types have been designed to meet the rigid specifications of the United States Navy Department, and their successful passage through the inspector's hands appears to be the best evidence of the standard which is being maintained by this company.

LARGE POWER UNITS.—The Administrative County of London and District Electric Power Company, which is responsible to a committee of the British House of Lords, is planning to construct three electric plants for generating current to supply the whole of London and those suburbs controlled by the London County Council. Each plant is to consist of six turbo-generators, each of 10,000 k.w. normal and 20,000 maximum capacity, making a maximum total of 360,000 k.w. As these power units are larger than any ever constructed, experts have been appointed to decide upon the practicability of units of this size. The electrical expert chosen for this important problem is Mr. C. F. L. Brown, of Brown, Boveri & Cie. The Crocker-Wheeler Company, American licensees, should be gratified by this mark of confidence in the ability of Mr. Brown.

STANDARD ROLLER BEARING COMPANY.—Mr. S. S. Eveland, vice-president and general manager of the Standard Roller Bearing Company, has purchased for that company the machinery, merchandise, assets and good will of the steel ball business of the Federal Manufacturing Company, of Cleveland. This transaction, which was for cash, amounted to a quarter of a million dollars. The Federal Manufacturing Company has manufactured steel balls for twenty years, and has the largest factory for that purpose in the world. The Standard Company bought the business of the Grant Ball Company a year ago, and since then has made from 4,000,000 to 5,000,000 balls per week. With the Federal Company's facilities moved to Philadelphia, the capacity will be increased to 500,000,000 balls per year. The extensive plant in Philadelphia has been enlarged to accommodate the additional machinery. Mr. Robert H. Grant, formerly of the Grant Ball Company, is superintendent of the Standard Roller Bearing Company; Mr. Thomas J. Heller is manager of the ball sales department; Mr. F. M. Germane is Western sales manager in Chicago, and Mr. S. S. Eveland is vice-president and manager. All of these gentlemen have had exceptional experience in the manufacture of ball and roller bearings.

REMOVAL OF AMERICAN STEEL FOUNDRIES.—The executive offices of the American Steel Foundries until lately were located at No. 74 Broadway, New York. With the object of concentrating all of the departments, it was found necessary to lease the entire eleventh floor of the recently completed building known as No. 42 Broadway, and henceforward communications should be sent to this new address. It is well known that in the new movement towards consolidation of allied industries one of the chief elements of success involves the systematizing and harmonizing of every branch of the business. With this end in view, the executive officers of the American Steel Foundries are inaugurating, simultaneously with the removal, a new system of accounting and distribution of orders, which will improve the organization and simplify their work. This will assist them in taking care of the many large orders they are receiving due to the increased demand for new equipment by the railroads and other large producers. The output of their eight plants for all kinds of steel castings is enormous, and they are always in a position to undertake new work and make prompt deliveries. With the acquisition of the Simplex Railway Appliance Company, they are even better equipped than ever to fill the requirements of railroad companies and car builders.

PHILIP CAREY MANUFACTURING COMPANY.—This company has recently completed a new roofing factory at Lockland, Ohio, which is one of the largest and best equipped roofing plants in the United States. The company was established in 1873 and has made a specialty of roofing manufacture in connection with a development of Carey's magnesia flexible cement roofing, which is well known among railroads, mining and construction companies and builders generally. The body of the roofing consists of a solid, flexible asphalt cement composition, tempered in the process of manufacture to a degree to enable it to resist wide ranges of temperature and adapting it to extreme northern or southern climates. The asphalt body is also protected by the construction of the roofing against the action of fumes, gases, heat and steam. It is stated to be less expensive than slate, tin, tar or gravel, and tests made at the insurance engineering experiment station by insurance experts resulted favorably for this roofing. It is used for both flat and steep surfaces and requires only ordinary careful labor for satisfactory application. Another important branch of this company's business is the manufacture of Carey's freight car roofing, which is made in 60-in. widths. This car roofing is designed to resist variations of temperatures as well as the jarring and motion of the cars of this severe service. The general offices and factories are located at Lockland, Cincinnati, Ohio.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

JUNE, 1905.

CONTENTS.

RATIONAL LOCOMOTIVE REPAIR RECORDS.

BY H. H. VAUGHAN.

SUPERINTENDENT OF MOTIVE POWER, CANADIAN PACIFIC RAILWAY.

The primary object of accounting, as applied to the affairs of a railway company or other business corporation, is that of comparing the receipts and disbursements during successive periods, and determining its financial condition. A mere statement, however, of the money earned and spent, while necessarily the most important, is not sufficient for the requirements of any large concern, and an elaborate system of statistical accounts has, during the past few years, been developed on every road, which are less directed to a statement of moneys earned and spent than to a detailed analysis of the various expenditures, which together make up the periodical disbursements of a rairoad company, and a determination of the corresponding work accomplished. These statements enable consecutive comparisons to be made, show the degree of economy with which the various services are carried on, and indicate the lines along which further economies may be effected, and their efficiency is measured by the clearness with which the information is presented and the accuracy of the relation between the costs and the work performed.

From the standpoint of a manager or operating official the statements that are prepared, showing the cost per day, per mile, or per ton mile, of the various items that enter into the total cost of transportation are, no doubt, satisfactory. They enable him to detect any undue increase in the cost of one or more individual details, and take the necessary steps to ascertain its cause; but while an operating official is thus informed amongst other figures of the cost of his motive power, the motive power official does not, as a rule, obtain any further analysis to enable him to assign a definite reason for the variations in his monthly results or determine to what extent they are serious and permanent. In making this statement no reference is intended to detail accounts, such as those showing from time to time the cost of making parts of locomotives or cars, or to payroll statements in their various forms; such accounts all roads have, and they are of great value, but a general analysis of the cost of maintenance, which may vary considerably from month to month, is not usually attempted, and the present article is intended to discuss the lines along which it may be developed.

The monthly cost of maintenance of locomotives is, properly speaking, not a single account, although it is usually treated as one, and it is chiefly for this reason that most of the attempts to make an intelligent analysis of it have failed. Its amount for each month does not necessarily bear any relation to the mileage made by the engines during that month, and, in fact, is frequently to a certain extent inversely proportional to it. Many conditions affect the cost per mile to a greater extent than does the management of the department, and the latter has occasionally obtained credit for results for which it was only slightly responsible, or been blamed when it was not in any way at fault. When a road is purchasing a large amount of new power and scrapping a corresponding amount of old, the costs will show a great reduction, whether any actual improvements in maintenance methods are made or not, and when this transition comes to a stop the costs will increase, and very possibly to an extent far greater than any reduction that could be effected by the most complete revolution in shop or roundhouse methods. While, then, to a manager the cost of repairs per mile or per ton mile is a figure that must be carefully watched, this figure is not for a particular month of any great value to a motive power officer, other than on account of the necessity imposed on him of keeping within such limits as will be acceptable to his superior officer, and its amount from month to month does not accurately inform him as to whether or not the results he is obtaining are satisfactory or enable him to compare them with those he previously realized.

As an example to illustrate the statement made, that the cost of maintenance of locomotives is not properly a single account, an allied expenditure for which the motive power department is generally held responsible, cost of roundhouse men may be considered. The amount of this should very properly be proportional to the mileage run in any month, as the force employed should depend on the number of engines dispatched, which corresponds very closely. It is true that if two hostlers are employed at a point and dispatch 1,000 engines one month, they cannot each be reduced to 0.9 of a hostler if 900 engines only are dispatched the next, but, on the whole, with a reduction in mileage some reduction may be made in the force, and vice versa. The expense will also vary somewhat in winter and summer, and is, of course, affected by rates, schedules, etc., but, on the whole, this is very properly a single monthly account, which can be properly compared on the basis of the mileage made by engines during each month

and watched from month to month, or from year to year accordingly. Each month is complete in itself, and a reduction in one month does not result in work being carried over to the next to any appreciable extent.

The maintenance of locomotive account is very different. A reduction in force may be ordered for some of the various reasons that induce that decision, or engines may have been worked up into condition for a temporary heavy business and the shop staff reduced. The engines go on making mileage, however, and the result is a low cost of repairs for the month. No real reduction has been made in the cost of repairs per mile, but the proportion of work that should have been done in that month has been anticipated or has simply been carried over and will have to be done later. If in the latter case the reduction is carried too far, the condition of the power may be affected, and a heavier expense incurred than had it been properly maintained. In any event, it is evident that a portion, at any rate, of the cost of maintenance has no relation to the mileage made in the corresponding month in the sense that the cost of roundhouse labor does.

There are, in reality, two factors entering into the cost of maintenance of locomotives, one of which may be termed the cost of running repairs, the other that of shop repairs. The first is a charge very similar in its nature to that of roundhouse men; it is properly a monthly charge, and varies in the same way with the mileage run. It is true that if running repairs are neglected, the condition of power will depreciate, but for equally good maintenance it is comparable from month to month, and its amount should vary in proportion to the mileage run, or the number of trips made by the engines, with due allowance for their character and the season of the year.

The second factor, the cost of shop repairs, is a charge of a very different nature; with no change in the actual cost of maintaining the power, it will vary from month to month, dependent chiefly on the amount of money devoted each month to shop repairs, and the amount of mileage run, but these figures are not necessarily proportional. Over a period of several months it is an indication of the economy with which the power is maintained, provided no change takes place in the condition of the power, no power is bought or scrapped, or that these factors are identical in the period with which comparison is to be made.

The cost of shop repairs must evidently be looked at somewhat differently from an account like running repairs or roundhouse men, and it is necessary to investigate what it actually represents. In each month a certain number of engines are passed through the shops for repairs. Each one has run a certain number of miles since previously receiving repairs, and the cost of repairing it is the cost of its shop repairs for the miles it has run since it last received repairs. Similarly for all the engines shopped in any one month the cost of the shop repairs for that month represents the costs of their shop repairs for the miles they have run since their last overhauling. The cost of shop repairs, then, in any month divided by the mileage made since last overhauling by the engines receiving repairs during that month represents the cost per mile for shop repairs for those engines. They are, of course, only a small proportion of the equipment, but nothing can be told from one month's figures of what those engines will cost for shop repairs that have not been shopped that month; all that is known, and the one thing that is known definitely, is what the engines cost that did receive repairs.

It is evident that by dividing the cost of shop repairs in any month by the mileage made by all the engines in service, that a figure is obtained that has no real meaning, since, if 20 engines are shopped one month and 25 the next, the amount spent on shop repairs may vary considerably, and if the same number of miles be run there will be an apparent difference in shop repairs, whereas, in fact, the 25 engines may have actually cost less per mile than the 20. If, on the other hand, the cost of each engine per mile for shop repairs is obtained, based on its cost of repairs and the miles it has run since last overhauling, the sum of these costs for the month shows the cost per mile for all the engines that received repairs during that month, and as month after month one engine after another passes through the shops and receives repairs, so figures are obtained showing the cost per mile for shop repairs, and when these figures are properly grouped and arranged, it can be seen month by month whether engines of similar types are costing more or less per mile for shop repairs.

Before discussing further the general features of accounts based on this method, it will be preferable to show how they are worked out in practice, as the principle is far easier to understand when shown in this way than when discussed in the abstract. The first step is, of course, the division of the maintenance of locomotive account into running and shop repairs. By running repairs, of course, are meant those generally handled in a roundhouse; but frequently fairly heavy repairs are made there, and, on the other hand, where the shop and roundhouse are close together, repairs that are properly roundhouse work are sometimes done in the shop, especially since overhead cranes have been introduced and an engine can be lifted so cheaply. It becomes necessary, therefore, to draw some line, and this may be done to suit the personal idea of the man in charge. There are advantages, however, in basing it on the amount of labor expended, and it will be assumed that repairs costing under $100 for labor are running repairs; those costing over that amount are shop repairs.

When, as is usually the case, time and material are charged against individual engines, it is a very simple matter to compile a statement showing the cost of running repairs each month by classes of engines and operating divisions, or where the number of different classes is large, it is preferable to divide the power into groups, each consisting of several classes which are substantially similar and which should cost the same for repairs, and determine the cost for each group instead of for each class. The material and labor costs should, of course, be separated, and it is also advisable to make a division between boiler work and other work, as, owing to the large variation in the cost of boiler work that is caused by a difference in the quality of the water on different sections, where it is separated, the cost of maintenance of machinery, etc., is of more value. The separation can be readily made from the payroll without the necessity of men booking their time to anything but the engine number, and while this plan is not absolutely accurate, it should be remembered that in statistical accounting, as distinct from financial, it is substantial accuracy that is needed, not absolute; the substance is required, not the form.

A statement as above described will show the cost, miles run, and cost per mile of the various classes or groups of engines on each division, and is therefore a complete general analysis of the cost of running repairs. It has, however, one serious defect, namely, that the cost and cost per mile of any class must be looked at together to understand the influence that any variation has on the total cost of running repairs for the month. One class may have cost a large amount per mile, and yet on account of the small mileage made by the engines included in it the influence on the month's results may not be serious. To make any particular figure valuable in a statement it is necessary not only to know its individual amount, but also to estimate its bearing on the grand total, otherwise too much consideration is required to properly utilize it. This can be conveniently shown by settling on an arbitrary rate for each class, and stating by what amounts its repairs are above or below the amount established by that standard.

A convenient method of showing this is by establishing a standard rate approximating that at which the work should be performed, and by showing the amount in each month that the work done actually cost more or less than it would have cost if carried out at the standard rate. It is not necessary that the standard rate should be established with any par-

STATEMENT I.
MONTHLY STATEMENT OF COST OF RUNNING REPAIRS.
ALL DIVISIONS, MONTH OF FEBRUARY, 1905.

Group.	Rate.	Labor.		Material.		Defect.	Total.	Mileage.	Per Mile.	Excess.	Decrease.
		Boiler Work.	Other Work.	Boiler Work.	Other Work.						
A	1.9	39.74	350.34	......	99.50	......	489.58	24,898	1.92	16.52	......
B	2.4	597.74	3,991.88	45.02	1,795.74	......	6,430.38	237,248	2.71	735.41	......
C	1.8	1.37	106.27	......	31.38	36.84	175.86	10,034	1.74	......	4.75
D	2.0	168.31	926.91	2.65	523.32	122.84	1,744.13	65,323	2.67	437.67	......
E	3.0	441.15	2,486.14	11.88	1,556.74	92.06	4,587.87	123,420	3.71	885.37	......
F	3.1	149.41	2,240.37	2.27	949.99	363.14	3,706.18	114,959	3.23	142.51	......
G	3.6	158.14	2,041.94	......	602.47	58.05	2,800.60	113,739	2.52	......	1234.00
H	2.0	......	30.19	......	13.19	......	43.38	1,681	2.58	9.76	......
J	1.6	......	3.64	......	21.99	......	25.63	1,718	1.48	......	1.86
K	2.4	51.57	504.07	.60	302.97	......	859.21	70,695	1.21	......	832.00
L	2.8	61.26	324.42	.53	319.34	......	705.55	59,863	1.18	......	964.62
		1,668.69	13,006.17	62.95	6,216.63	672.93	21,628.37	823,578	2.63	......	809.99

Per 100 Per Cent. Mile, 1.93.

STATEMENT II.—GROUP X.

Month.	Engine	Rate.	Repairs. At.	M	T	F	D	Mileage. Engine.	Mileage. Period.	Cost. B. W.	Cost. O. W.	Cost. Total.	Per Mile.	Excess.	Decrease.	Total to Date.	Per Mile.
Sept..	231	1.62	Carleton Jct.	1	1	..	E	35,094	......	107.30	826.85	934.15	2.66	368.87	......	......	...
	279	...	Carleton Jct.	1	2	..	E	64,837	......	118.98	761.03	880.01	1.35	......	173.59	......	...
	393	...	Carleton Jct.	1	1	..	E	29,606	129,537	224.76	757.40	982.16	3.31	501.06	......	691.34	.53
Oct...	391	...	Carleton Jct.	1	1	..	E	65,218	......	186.48	658.94	845.42	1.3	......	214.87	......	...
	288	...	Toronto Jct.	1	1	..	O	40,228	......	233.27	970.05	1,203.32	2.99	549.62	......	......	...
	290	...	Toronto Jct.	3	2	..	O	......	......	46.80	402.30	449.10	...	449.50	......	......	...
	294	...	Toronto Jct.	1	1	..	O	73,492	308,475	97.45	957.42	1,054.87	1.44	......	139.37	1,336.72	.42
Nov...	287	...	Toronto Jct.	2	..	..	O	17,737	......	24.40	395.46	419.86	2.36	131.64	......	......	...
	293	...	Toronto Jct.	3	..	..	O	......	......	1.91	20.26	22.17	...	22.17	......	......	...
	296	...	Toronto Jct.	3	..	..	O	......	......	7.97	208.47	216.44	...	216.44	......	......	...
	298	...	Toronto Jct.	1	1	..	O	101,324	......	87.89	859.41	947.30	.93	......	699.20	......	...
	390	...	Angus.	1	1	..	E	80,582	......	237.75	1,149.34	1,387.09	1.72	77.63	......	......	...
	366	...	Carleton Jct.	1	2	..	E	60,987	......	68.99	1,011.29	1,080.28	1.77	89.26	......	......	...
	383	...	Carleton Jct.	1	1	..	E	53,728	622,833	122.03	1,214.63	1,336.66	2.48	463.58	......	1,638.24	.26
Dec...	299	...	Carleton Jct.	1	2	..	E	81,080	......	29.34	776.25	805.59	.94	......	511.96	......	...
	277	...	Carleton Jct.	1	2	1	E	40,560	......	29.33	630.17	659.50	1.62	.40	......	......	...
	379	...	Carleton Jct.	1	1	..	E	82,806	......	67.15	692.12	759.27	.91	......	586.33	......	...
	388	...	Carleton Jct.	1	1	..	E	79,646	......	117.56	802.33	919.89	1.15	......	374.36	......	...
	281	...	Carleton Jct.	1	1	..	E	83,054	989,979	119.48	1,089.39	1,209.37	1.45	......	140.27	E 25.72	...
1905. Jan...	232	...	Carleton Jct.	1	1	..	E	34,191	......	129.11	820.06	949.17	2.72	393.56	......	......	...
	292	...	Toronto Jct.	1	1	..	O	45,785	......	387.86	806.57	1,194.43	2.6	450.42	......	......	...
	293	...	Toronto Jct.	1	1	..	O	42,930	1,112,885	113.99	1,022.84	1,136.83	2.64	439.22	......	1,308.92	...
Feb...	297	...	Toronto Jct.	2	..	..	O	31,718	......	5.98	226.15	232.13	.73	......	283.30	......	...
	367	...	Carleton Jct.	1	1	..	E	97,020	......	137.04	898.30	1,035.34	1.06	......	541.23	......	...
	359	...	Carleton Jct.	1	1	..	LS	181,876	1,423,499	122.30	1,070.15	192.45	.65	......	1,763.03	D1,278.64	.70

STATEMENT III.—SUMMARY OF SHOP REPAIRS.

ALL DIVISIONS............ MONTH ENDING FEBRUARY, 1905.

Group.	Rate.	Month. Mileage.	Month. Boiler Work.	Month. Other Work.	Month. Total.	Month. Per Mile.	Month. Excess.	Month. Decrease.	Period. Mileage.	Period. Boiler Work.	Period. Other Work.	Period. Total.	Period. Per Mile.	Period. Excess.	Period. Decrease
A	1.50	6,878	37.74	151.50	189.24	2.75	86.07	......	1,188,775	6,491.37	20,431.43	26,922.80	2.26	9,091.18	......
B	1.62	310,614	265.32	2,194.60	2,459.92	.79	......	2,587.56	1,423,499	2,825.56	19,027.18	21,852.74	1.53	......	1,279.57
C	1.50	67,102	185.44	724.77	910.21	1.36	......	96.32	212,645	654.58	4,345.57	5,000.25	2.35	1,599.17	......
D	2.0	122,632	374.65	1,527.28	1,901.93	1.55	......	550.71	415,582	1,498.50	6,842.25	8,340.75	2.0	29.11	......
E	2.37	......	......	......	......	....	......	......	12,573	560.50	463.79	1,024.29	5.16	725.58	......
F	2.5	......	......	......	......	....	......	......	41,017	383.63	1,937.95	2,321.58	5.65	1,296.17	......
G	2.5	100,837	317.85	2,056.81	2,374.66	2.37	......	146.26	549,989	3,284.66	13,415.49	16,700.15	3.01	2,950.42	......
H	2.62	45,985	282.26	1,668.93	1,951.19	4.25	744.07	......	201,588	2,072.96	7,844.81	9,917.71	3.38	4,620.08	......
I	3.37	165,859	1,289.20	6,614.48	7,903.68	4.77	2,305.94	......	622,371	6,897.29	33,774.70	40,671.99	6.52	19,963.88	......
J	3.75	......	208.00	271.01	479.01	....	479.01	......	275,686	1,158.99	5,176.78	6,335.77	2.3	......	4,002.46
K	2.37	......	54.11	165.59	219.70	....	219.70	......	222,592	1,319.65	5,538.61	6,858.26	3.08	1,571.68	......
L	3.0	173,185	727.24	4,099.64	4,826.88	2.78	......	368.67	1,326,380	10,994.43	40,219.39	51,213.82	3.86	11,422.42	......
M	2.25	51,819	209.21	1,158.87	1,368.08	2.64	202.17	......	51,819	438.22	2,622.26	3,060.48	5.9	1,894.57	......
N	2.5	64,013	249.62	1,294.70	1,544.32	2.41	......	56.01	405,522	2,584.44	11,268.66	13,853.10	3.42	3,715.05	......
O	3.75	95,472	350.74	3,602.61	3,953.35	4.14	373.15	......	602,504	3,590.60	21,533.53	25,130.13	4.16	2,534.00	......
P	3.87	60,714	644.30	3,015.14	3,659.44	6.02	1,286.77	......	668,041	5,122.36	29,936.56	35,058.92	5.25	9,172.33	......
Q	4.5	......	1.22	129.35	130.57	....	130.57	......	......	29.73	677.01	706.74	....	706.74	......
R	2.5	......	......	......	......	....	......	......	......	......	......	......	....	......	......
S	2.0	......	2.73	151.11	153.84	....	153.84	......	......	2.73	151.11	153.84	....	153.84	......
T	3.0	......	......	......	......	....	......	......	333,897	1,096.51	5,925.51	7,022.02	2.1	......	2,994.69
U	3.5	29,695	355.57	1,147.87	1,503.44	5.06	464.12	......	212,675	1,470.47	6,845.37	8,315.84	3.91	872.21	......
Total...		1,294,805	5,555.20	29,974.26	35,529.46	2.74	2,639.89	......	8,767,215	......	......	290,461.64	3.31	64,052.51	......

Per 100 Per Cent. Mile, 2.70. Per 100 Per Cent Mile, 3.20.

STATEMENT IV. (PART 1.)

INDIVIDUAL RECORD OF COST OF LOCOMOTIVE REPAIRS.

RATE PER MILE RUNNING, 1.6; SHOP, 2.0. TOTAL, 3.6. GROUP B 2.

Engine No.	Division.	Total Mileage.	Running Repairs.						Intermediate Repairs.										
			Labor.		Material.		Defect.	Total.	Mach.		Tubes.		F/ /B	Labor.		Material.		Total.
			Boiler Work.	Other Work.	Boiler Work.	Other Work.			2	3	1	2		Boiler Work.	Other Work.	Boiler Work.	Other Work.	
306	E	75,275	89.41	528.57	24.05	144.42	......	786.45	1	..	—	1	..	110.35	696.00	9.24	105.70	921.29
399	O	64,180	105.86	468.31	28.25	127.03	42.15	771.60	..	1	..	..	..	12.21	37.04	2.19	13.35	64.79
303	E	80,453	121.15	589.26	31.08	140.11	......	871.60	..	..	..	..	..	......	......	......	......	......

ticular accuracy provided it divides the operations, which it is desired to compare, into those which cost more and those which cost less than its amount. But its introduction into a statement causes the items requiring attention to stand out clearly, and determines in dollars and cents, each month or period, the effect of high costs as compared with the amount which would have been spent, had these been reduced to a lower rate.

In order to obtain a coherent relation, the arbitrary rate should be based on some quantity of the engine, such as its weight or tractive power, so that for all classes a cost per engine mile per engine ton mile or per 100 per cent. mile may be obtained, and it will in this article be considered as based on the 100 per cent. engine mile, a 100 per cent. engine being one with a tractive effort of 20,000 lbs.

A sample statement for one division for one month compiled in this way is shown below, the group numbers being fictitious, the other figures those taken from an actual statement, in which the standard rate is taken at 2 cents per 100 per cent. mile. It is evident that it shows almost at a glance the relative amounts spent in maintaining the various classes, how one division varied from the other, and how important any increased or decreased cost was in relation to the total amounts spent, and while this statement only shows the month's results, it can evidently be easily arranged to show those for any desired period in addition, as for instance from the commencement of the fiscal year, and it is recapitulated on this Statement I., to show the total results on all divisions.

The statement showing the cost of shop repairs is somewhat different. If an engine after receiving a general overhauling simply received running repairs until it again came to the shops the case would be very simple, but this is not what happens. It is very general practice, on many roads at any rate on certain classes of engines, to bring an engine in for light repairs once or even twice between each general repair, and there are in addition specific shop repairs performed, such as those necessitated by broken parts, and heavy roundhouse work which may perhaps run into $200 or $300, by which a few worn out parts are repaired and further mileage obtained from the engine. It is obvious that if an engine were considered shopped when it received intermediate repairs that its cost per mile would be low, whereas when it came in and received a general overhauling its cost would be high, as there would only be the mileage since its intermediate repairs to compare with the cost of the general overhauling. If an intermediate repair costs one-half of a general repair, it is evident that if for instance an engine ran 30,000 miles and received an intermediate repair, then ran 30,000 more and received a general, it would be proper to take 20,000 miles as the proper amount on which to base the cost of the intermediate repair, leaving 40,000 on which to base the cost of the general. Intermediate repairs do not necessarily bear that relation to the general, and as the object should be to obtain results that are if anything on the safe side, it is preferable to only allow one-half of the mileage made to an intermediate repair in determining the cost per mile, leaving the other half to be used when an engine is shopped for a general overhauling. In the case of specific repairs no definite mileage can be allowed. They are liable to be required at any time, and the best way is to include their cost without allowing any mileage credit; they are items that have to be taken care of.

The principle of comparing the actual cost of running repairs with an arbitrary figure can be even more conveniently used in a shop repair statement, but an additional figure is required. One month's results in shop repairs is too variable to be of value by itself; it is necessary to know what they are over a considerable period; this can be shown by attaching to each month's results a statement showing the results for the last period of six months, including the current one. Then each statement shows for a six months' period the results obtained, and the variation in that time from the standard cost. The statement for one class of engines on this system is as follows, the repairs being classified as described in the AMERICAN ENGINEER, January, 1905, page 27, No. 1 machinery being considered as general, No. 2 machinery as intermediate, and No. 3 and defect as specific repairs, and the standard rate being based on 2½ cents per 100 per cent. mile. Statement II. illustrates this.

Such a statement shows for this class of engines just what the cost per mile for shop repairs was for the month, which engines ran above and which below the standard, how the cost and mileage of each engine affected its cost per mile, and what effect specific repairs had on the general results, and how the costs for the month compare with and affect those for the period. It is not necessary to separate engines by divisions on this sheet, as if the division is shown those requiring attention are easily noted by the excess and decrease columns. Statements similar to this made out for each class are easily recapitulated by divisions, and such a recapitulation for all classes and divisions is as shown in Statement III., which is made up for each division.

This recapitulation is in actual working the most valuable statement of the series. It shows at a glance which engines have cost above or below the average, what their cost per mile was and what effect its variation has had in dollars and cents upon the results for the month and period. The divisional recapitulation shows the results for each division, and may be used for their comparison. With a personal knowledge of the conditions existing at the time it can be told whether the increase in any class is likely to be permanent or not, and shows which engines are expensive or cheap to maintain. By reference to the class sheets the individual engines causing any variation can be located and the reason ascertained.

The recapitulation shows the total cost per mile and per unit mile for all the engines shopped during the month and period, and it evidently gives a figure that is independent of the amount of shopping done each month, of the mileage run each month and of any variation in the condition of power, all of which conditions affect the figure usually derived by dividing the cost of shop repairs by the miles run during the month. The latter figure is very similar to that which would be obtained, if in a power plant producing a variable number of kilowatt hours each month with a large storage capacity for coal, the cost per k.w. hour were arrived at by dividing the coal purchased each month by the k.w. hours produced. If one month 1,000 tons of coal were purchased and the next month 500 and the k.w. hours were the same, there would be a tremendous difference in the cost. If 10,000 tons were on hand, the purchases each month could be arranged to show a low cost for a considerable time, but the results obtained would in reality be no better. Just such a condition exists in locomotive operation, the k.w. hours corre-

STATEMENT IV. (PART 2.)

INDIVIDUAL RECORD OF COST OF LOCOMOTIVE REPAIRS.

RATE PER MILE RUNNING, 1.6; SHOP, 2.0. TOTAL, 3.6. GROUP B 2.

	No. 1 Machinery Repairs.							Running Repairs.			Shop Repairs.				All Repairs.		
			Labor.		Material.												
Station.	Tubes.	Firebox.	Boiler Work.	Other Work.	Boiler Work.	Other Work.	Total.	Per Mile.	Excess.	Decrease.	Per Mile Inter	Per Mile Final.	Excess.	Decrease.	Per Mile.	Excess.	Decrease.
Angus.	1	2	205.41	720.30	65.24	185.78	1,176.73	1.04	...	417.95	2.45	1.56	592.52	......	3.83	174.57	......
Tor. Jct	1	..	187.30	841.07	49.26	442.91	1,520.54	1.13	...	255.29	....	2.37	301.73	......	3.66	46.44	......
Angus.	..	..	199.19	985.81	74.15	320.44	1,579.59	1.08	...	415.65	....	1.96	......	29.47	....	......	445.12

spond to the miles run, the cost of coal to the cost of shop repairs and the condition of the power represents a very large stock and it can be drawn on to quite an extent for a time, but no real saving is obtained by doing so; in fact, the reverse is the case. In tne system of accounts outlined above, each lot of k.w. hours is compared to the cost of coal required to produce it; in other words, the cost per k.w. hour of the coal used is shown, whereas on the other system the cost per k.w. hour of the coal bought is the figure obtained.

These shop repair statements in conjunction with that for running repairs make a very complete and in reality a simple and easily used analysis of the cost of repairs. Another statement may also be compiled to advantage to connect the running repairs and shop repairs on each individual engine; and while rather lengthy it is easily made up from the information previously obtained. While the running and shop repairs have been obtained separately, it would not be possible to determine whether an engine that was light on running repairs was heavy on shop and vice versa; nor the effect of making specific and intermediate repairs on the cost of the general overhauling. Statement IV., which is self-explanatory, connects these various costs together for each engine receiving general repairs and is of considerable value as a matter of record.

The cost per mile, as shown in these various statements, will not even on the average compare with that obtained in the usual way, except on the one condition that for a considerable period no power is bought or scrapped and the condition is maintained the same, but it will in general be greater. If any engine is scrapped it is evident that the mileage should be credited to the mileage shopped without any corresponding cost for shop repairs, and this may be done if desired, but it reduces the value of the comparison showing what the engines shopped are actually costing per mile. The purchase of new power introduces a complication that cannot be allowed for accurately, but it approximately reduces the cost of shop repairs on the mileage run basis in the ratio of the number of engines bought to the total. The value of these statements is not, however, to tell what the cost per mile will be on the general accounts, but to tell the department itself what it is doing and explain the reasons for its results. They can mislead but slightly, as if a light repair is called a general it shows better results for that month, but just as soon as that engine needs its general repairs, the error is rectified, and in fact if kept accurately these accounts are very positive, and they occasionally show results that are not in the least expected. While they may appear complicated, they are exceedingly easy for a busy man to follow, as the important figures stand out clearly and are few in number, and the number of engines receiving shop repairs each month even on a large road is not sufficient to become confusing and it is only those that are individually followed. With the proper system for compiling the figures they are not expensive, one man being able to prepare the statements for 1,000 engines. The system could evidently be applied to car repairs, especially if put on a monthly in place of a mileage basis and would afford equally good results.

The advisability of introducing a system of statistical accounts for the motive power department, that have no direct connection with the general accounts of the road, may be objected to, but the fact remains that those acounts are not so compiled as to permit an accurate comparison of the results obtained or to be of any assistance in locating a source of undue expenditure. Neither do they enable a superintendent of motive power to compare the results obtained on several divisions in a rational and definite manner. This system of accounts brings out in a clear and positive form the value of mileage between shoppings as being of equal importance to the cost of an engine shopped. It reveals in its money value the loss that occurs when an engine is improperly maintained and has to be prematurely shopped. It clearly defines the various and complicated factors that together make up the total of the maintenance of locomotive account.

TEST OF ALFREE-HUBBELL VALVE GEAR.

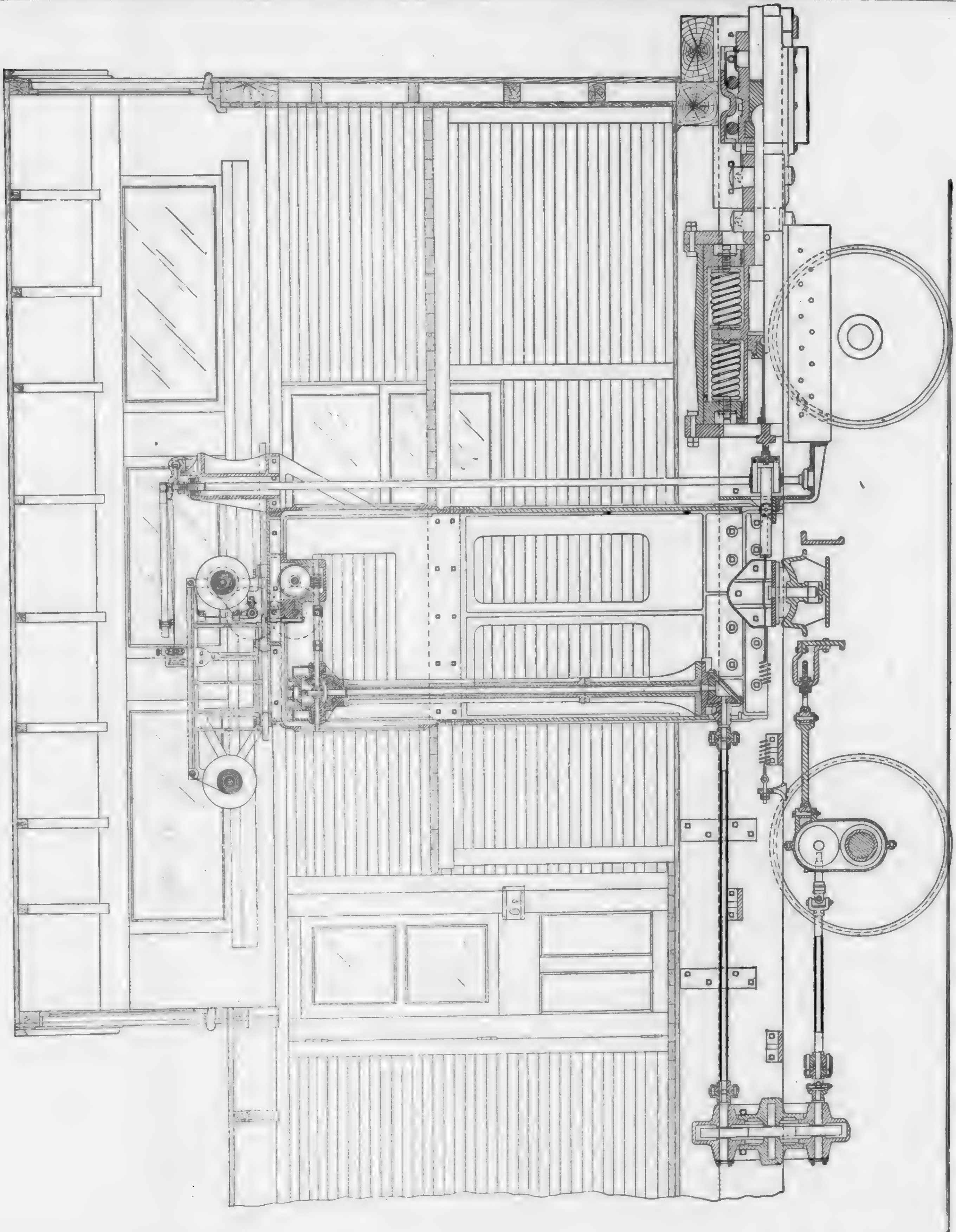
Engine No. 581 of the Central Railroad of New Jersey, which is equipped with Alfree-Hubbell vaive motion and cylinders, has been compared with engine No. 582, which is similar in all respects except that it has the usual link motion and American balanced valve. The tests were made between Jersey City and Philadelphia on the same train, with the same engineer and fireman and conditions were kept as nearly alike as possible. The results of a round trip with each engine, which represented normal conditions, are given in the accompanying table. These tests show a saving in coal of 10 per cent. and a saving in water of 10.45 per cent. In this case engine No. 582 had a nozzle ⅛ in. larger than that of the Alfree-Hubbell engine. Other tests showed a saving in coal of 16.1 per cent. and in water of 15.92 per cent. in favor of the Alfree-Hubbell engine, these figures being deduced from the pounds of water and coal per ton mile. The report states that this saving, however, is larger than would actually occur under normal conditions.

In the tests showing the larger figures of saving the results were involved with the use of steam heat for the train. The results given in the table are believed to represent normal conditions.

We are indebted to Mr. William McIntosh, superintendent of motive power, and Mr. B. P. Flory, mechanical engineer, of the Central Railroad of New Jersey, for this information.

	5-in. Nozzle. Engine 581.	5⅛-in. Nozzle. Engine 582.
Weight of train, tons	173.35	172.9
Weight of coal, pounds	7,706	8,502
Weight of water, pounds	65,381	72,826
Pounds coal per ton mile	.2455	.273
Pounds water per ton mile	2.087	2.3306
Average steam pressure	189.8	181.8
Number of minutes blow-off	107	51.0
Average speed, M. P. H.	45.97	47.01
Saving coal, per cent	10.00	....
Saving water, per cent	10.45	....

A 5,000-HORSE-POWER GAS ENGINE PLANT.—The California Gas & Electric Corporation has adopted gas engines, three in number, of 5,333 h.p. each, for the new plant for the operation of the street railway system of San Francisco. Oil gas will be used, and the engines will be direct connected to 4,000 k.w. 25-cycle alternators built by the Crocker-Wheeler Company. This involves the largest gas engines ever constructed in the United States. The low cost of crude petroleum in California determined the selection in favor of a gas engine plant.

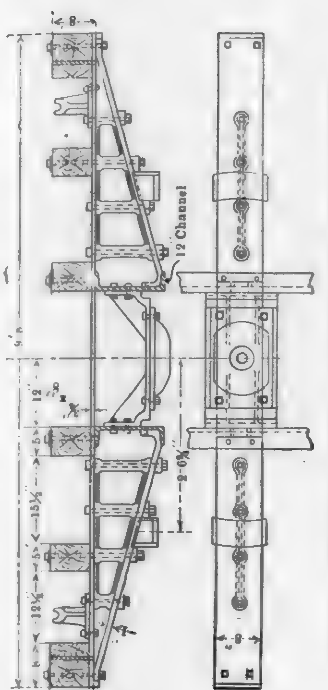


DYNAMOMETER CAR, NEW YORK CENTRAL LINES—SHOWING DRAFT AND RECORDING MECHANISM.

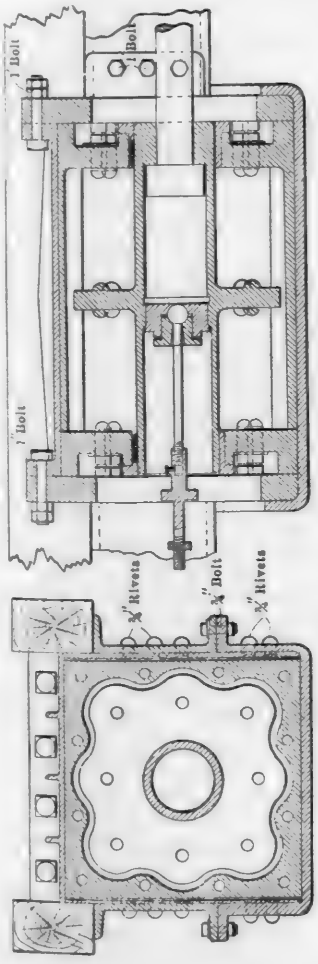
DYNAMOMETER CAR.

NEW YORK CENTRAL LINES.

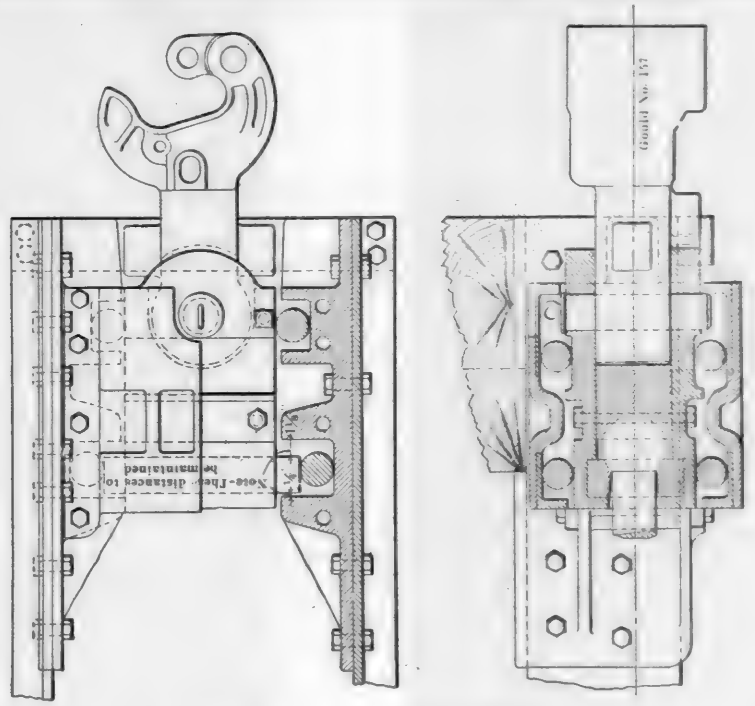
The new dynamometer car, which is illustrated from drawings received from Mr. F. M. Whyte, general mechanical engineer of the New York Central lines, has just gone into service. This is a new car built specially for the purpose. The design of this car itself was influenced by a desire to place the recording mechanism in the cupola in order to place the operators in a position of advantage in recording mile posts and other road data. For this reason the cupola is made high, and the body of the car low, so that the operators may see over the body of the main portion of the car. This car is 44 ft. long, with the dynamometer gear in one end; two sleeping-car sections, a kitchen, toilet-room, and heater in the other end, with a writing desk, work bench and recording table in the center. The platform of the cupola is 3 ft. 11 ins. above the main floor. The car has 6 wooden sills and 2 sills in the form of 12-in. channels. These are spaced 24 ins.



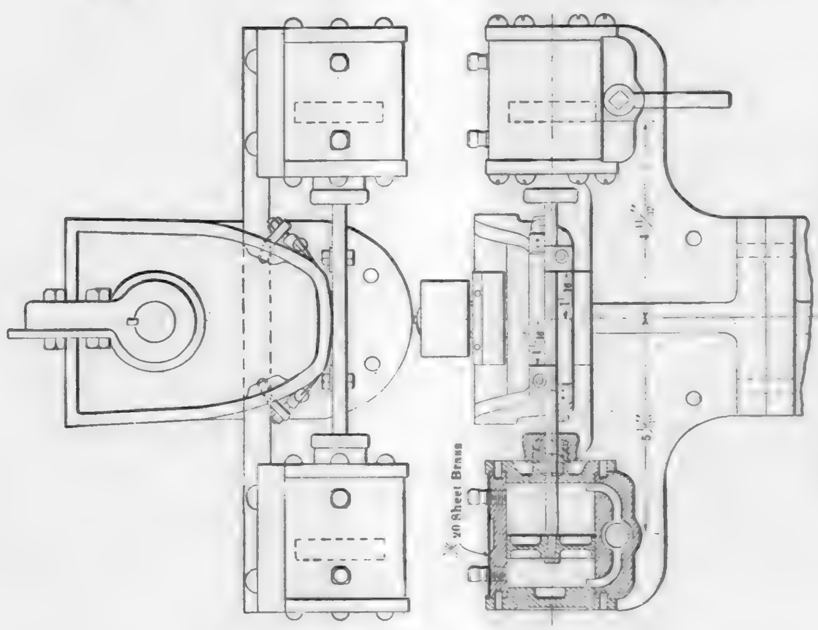
SECTION THROUGH FLOOR FRAMING AND BODY BOLSTER.



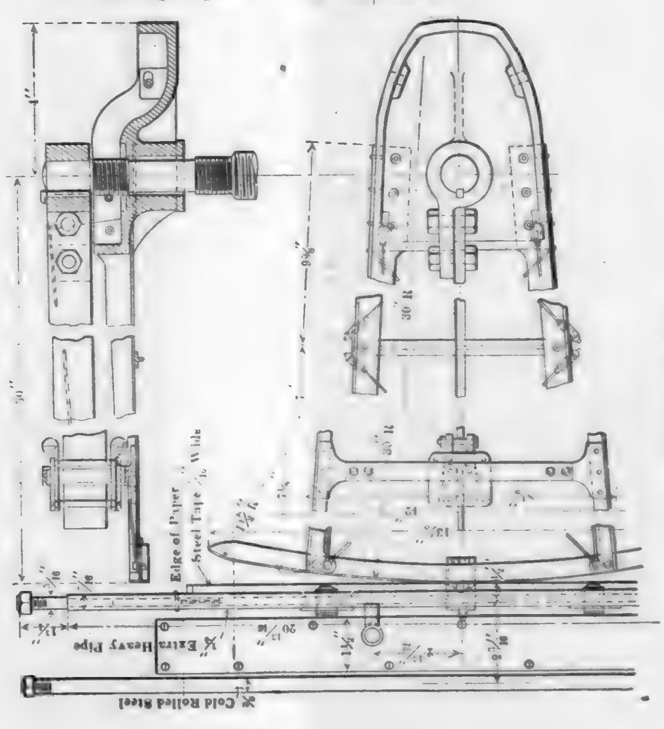
DRAFT GEAR SHOWN WITH SPRINGS OMITTED.



COUPLER ATTACHMENT.



DASH POTS FOR RECORDING ARM.



RECORDING ARM.

DYNAMOMETER CAR, NEW YORK CENTRAL LINES.

apart, in order to provide for the dynamomenter springs and extend the full length of the car. Upon these channel sills rests a frame of cast steel plates, which supports the recording table, and forms a rigid connection between the draft sills and the table. To increase the stiffness of the car, end platforms are omitted.

The general arrangement of the dynamometer and the recording mechanism is quite similar to that of the Chicago & Northwestern dynamometer car, illustrated in this journal in June, 1900, page 172. The construction is modified because of a higher recording table, but the paper-driving mechanism, the dynamometer itself and the recording devices are similar. Springs, 16 in number, are arranged in two sets, with a follower between them. The casing gives these springs an initial compression. The free height of the springs is 10¾ ins. for one side, and 11¼ ins. for the other side; one set gives 50,000 lbs. capacity and the other set 100,000 lbs. The purpose of the initial compression in the springs is to cause the discrepancies between the deflections of increasing and decreasing loads to neutralize each other. The initial load is sufficient to guard against either side becoming entirely unloaded in the maximum draw bar pull. The recording movement is taken from the central follower, to which the coupler is attached, the pull and thrust of the draw bar being transmitted to the draft sills through the casting containing the springs. The vertical shaft connects the motion of the draw bar to the recording arm, which connects with a pencil arm by means of flexible steel bands. The pencil arm extended upon the opposite side of its pivot connects with a pair of dash pots, communicating motion to the arm by means of flexible steel bands.

The paper-driving mechanism is clearly shown in the engraving, which also illustrates the clutch for reversing the motion as the direction of the movement of the car is changed, thus always keeping the paper moving in the same direction. The pencil arm moves back to the datum position under the influence of the long steel spring, which also keeps the slack out of the motion. The vertical shaft leading to the pencil arm is supported upon ball bearings. The recording mechanism is equipped with an automatic integrator, and pens actuated by electricity are provided for the time, mile post, indicator card and other data.

The draw bar is carried on a special yoke, with roller bearings to carry its weight and take the side thrusts. This involves the use of horizontal and vertical rollers. The trucks have four wheels, each with equalizers; the wheel base being 8 ft.; the wheels being 35 ins. in diameter.

The speeds of the paper, as determined by the gearing and the driving mechanism, are such as to record 1-16, ⅛, ¼, ½ and 1 mile per ft. on paper.

COMMON STANDARD LOCOMOTIVES.

Harriman Lines.

Last month comparative dimensions and weights of the four standard locomotives for the Harriman Lines were presented with a brief statement of some of the parts which are made standard to all locomotives. Some of the details may now be recorded.

All classes of locomotives have the same eccentric strap. This was made in cast steel with a light webb section, as indicated in the sectional drawing. The section and side view illustrates the loose ring which is made in three parts and of brass. This ring is not secured either to the eccentric or to the strap and may revolve freely. It is provided with six ⅜-in. oil holes to carry lubricant from the outside to the inside. The oil cups are cast with the strap and two cups are provided at the lower side of the strap, having removable plugs in order to clean them. This standard permits of the use of one pattern of eccentric strap for passenger, freight and switching locomotives.

Eccentric.—One eccentric design fits all classes of engines. The eccentric throw is 5 ins., as shown in the drawing, the forward motion eccentric has a 6-in. bearing on the axle, whereas the backward motion has but 4¼ ins. This was done in order to avoid too great an offset in the eccentric rods and this arrangement makes it possible to use two eccentric patterns for all new locomotives on the system. The eccentrics are secured with key and set screws, the two halves of the backward motion eccentric being secured together by studs and those of the forward motion secured by studs and also by bolts on the projecting hubs.

Driving Boxes.—These are all cast steel and are of two sizes, one being 9 x 12 ins., common to all engines, and the other 10 x 12 ins., which is used for the main boxes of the consolidation and Pacific types. As the designs are in all respects similar, except as modified for the two journal diameters mentioned, the larger one only is shown. These boxes have substantial brasses 2¼ ins. thick at the crown and with four ½-in. oil holes from the oil pocket leading to the cavity at the center. Two strips of babbitt 2 ins. wide are let into the brass as indicated. The entire outer face of the outside of the box is babbitted in a dovetail groove. The cellar is of cast iron and is provided with a removable plate on the inside for convenience in packing.

Cross Head.—One cross head fits all engines. The body is of cast steel and the removable shoes are of bronze. The shoe area is 5½ ins. wide by 24 ins. long. The engraving also shows the cross head pin and piston rod end. This cross head is light and convenient to maintain. Oil cups are cast in the lower shoes and attached through the body of the cross head for the upper shoes. Each shoe is secured to the body by 4 bolts.

Wheels.—All the driving wheel centers are of cast steel with cavities for counterbalances of lead, which are figured by the Master Mechanics' Association rule. All of the driving wheels of the standard engines are shown, and weights, together with the counterbalance weights, are presented in the accompanying table. It will be noticed that in order to get approximately the same cylinder spread on all of these engines, viz., 89 ins. for the Pacific and Consolidation types; 88 ins. for the Atlantic type, and 87 ins. for the switcher, the length of the hubs of the driving wheels differ. It will be noted that in all cases the estimated weight of each crank pin hub is given in the table. The tires of the Pacific and Atlantic type are shrunk on and bear against a shoulder on the outside of the tire. The drawings show the distance of the center of gravity of the counter balance of each wheel from the center of the axle.

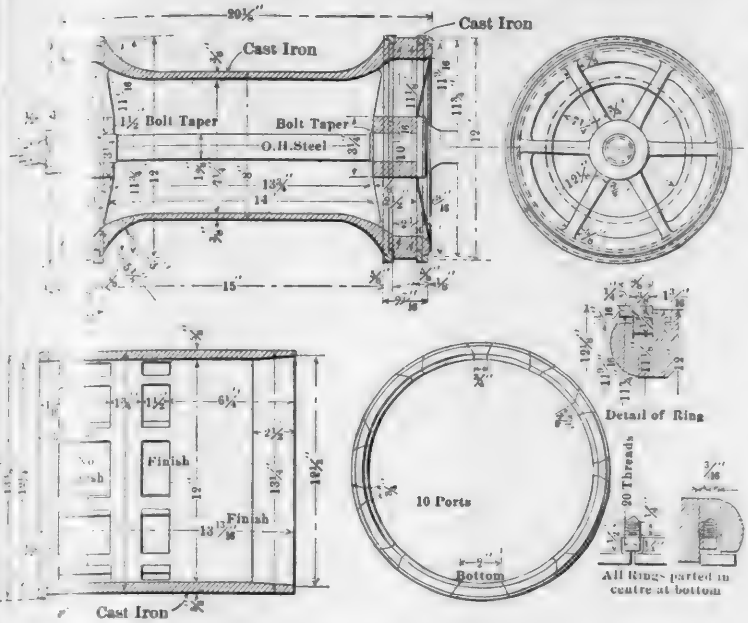
Truck Wheels.—All truck wheels have cast iron centers and steel tires made by the Standard Steel Works. For the Atlantic and Pacific types the truck wheels are 33½ ins. in diameter. The normal weights are as follows:

Tire when finished	480 lbs.
Tire when rough	540 lbs.
Center when finished	435 lbs.
Center when rough	475 lbs.
Two retaining rings	55 lbs.
Bolts and nuts	10 lbs.
Finished wheel	980 lbs.

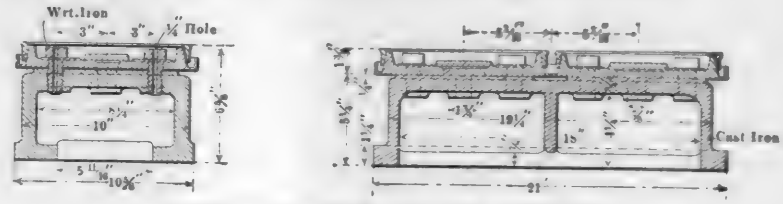
The truck wheels of the Consolidation types are 30½ ins. in diameter. The normal weights are as follows:

Tire when finished	434 lbs.
Tire when rough	490 lbs.
Center when finished	392 lbs.
Center when rough	445 lbs.
Two retaining rings	48 lbs.
Bolts and nuts	10 lbs.
Finished wheel	884 lbs.

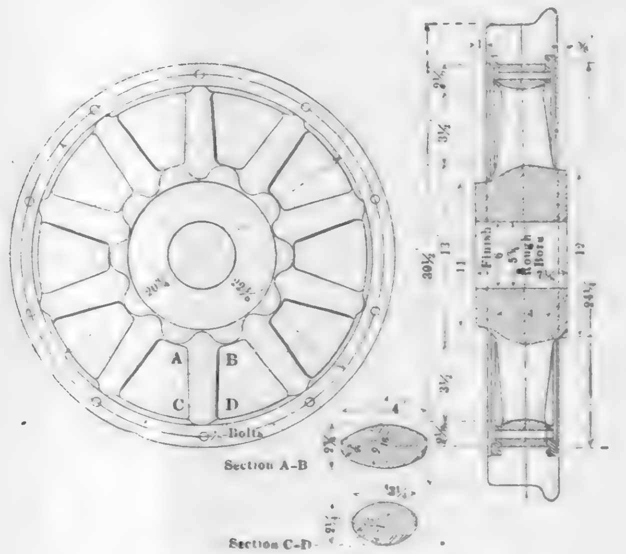
Valves.—The valves of the switcher are of the flat type with American balance, using two rings, all the rest are of the piston type, 12 ins. in diameter, one valve serving for all the road engines. This valve is of cast iron with 2 L-shaped rings at each end. The valve rods are all 2 ins. in diameter and vary in length only. The piston valves have internal admission, the motion being indirect and the eccentric rods are crossed. The engraving of the valve also illustrates the bushing and ports. The valve stems are not extended. Two pis-



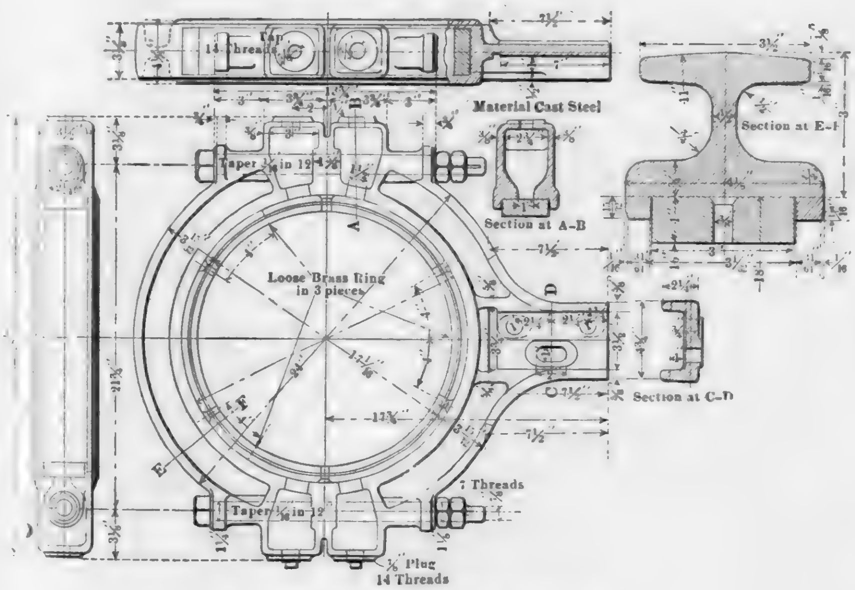
PISTON VALVE FOR ROAD ENGINES.



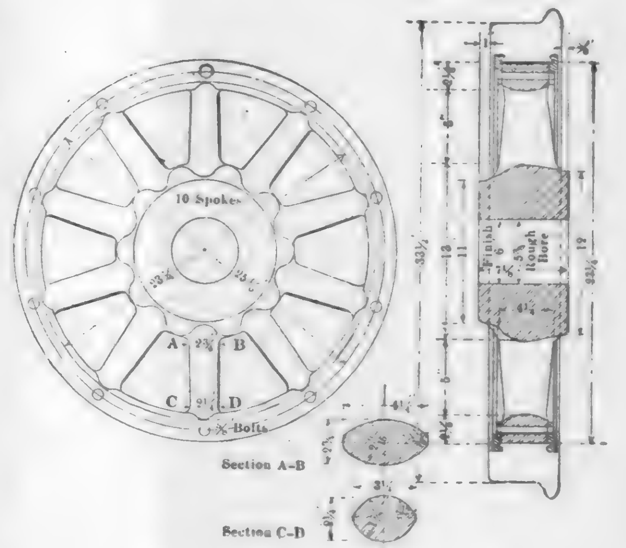
AMERICAN BALANCED VALVE FOR SWITCHERS.



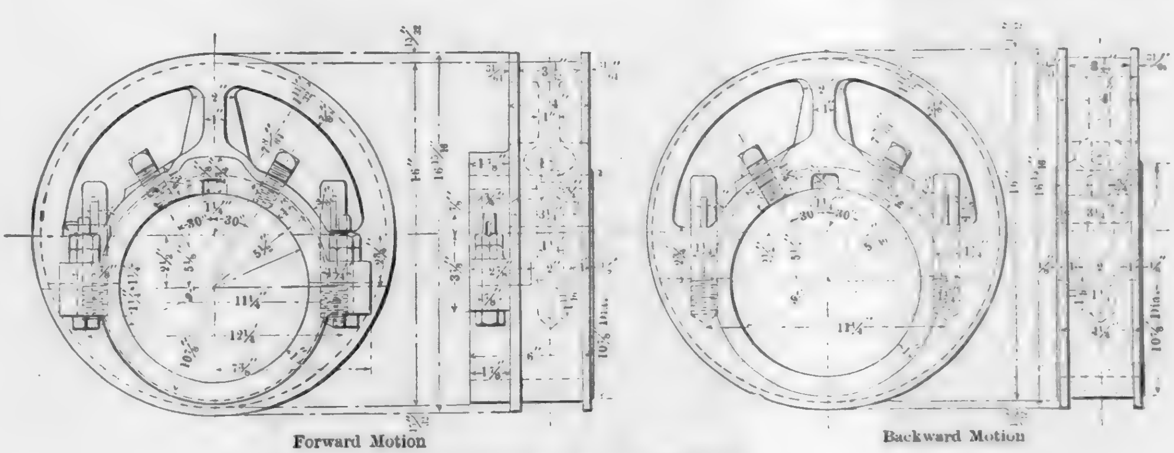
TRUCK WHEEL, CONSOLIDATION TYPE.



ECCENTRIC STRAP, ALL ENGINES.

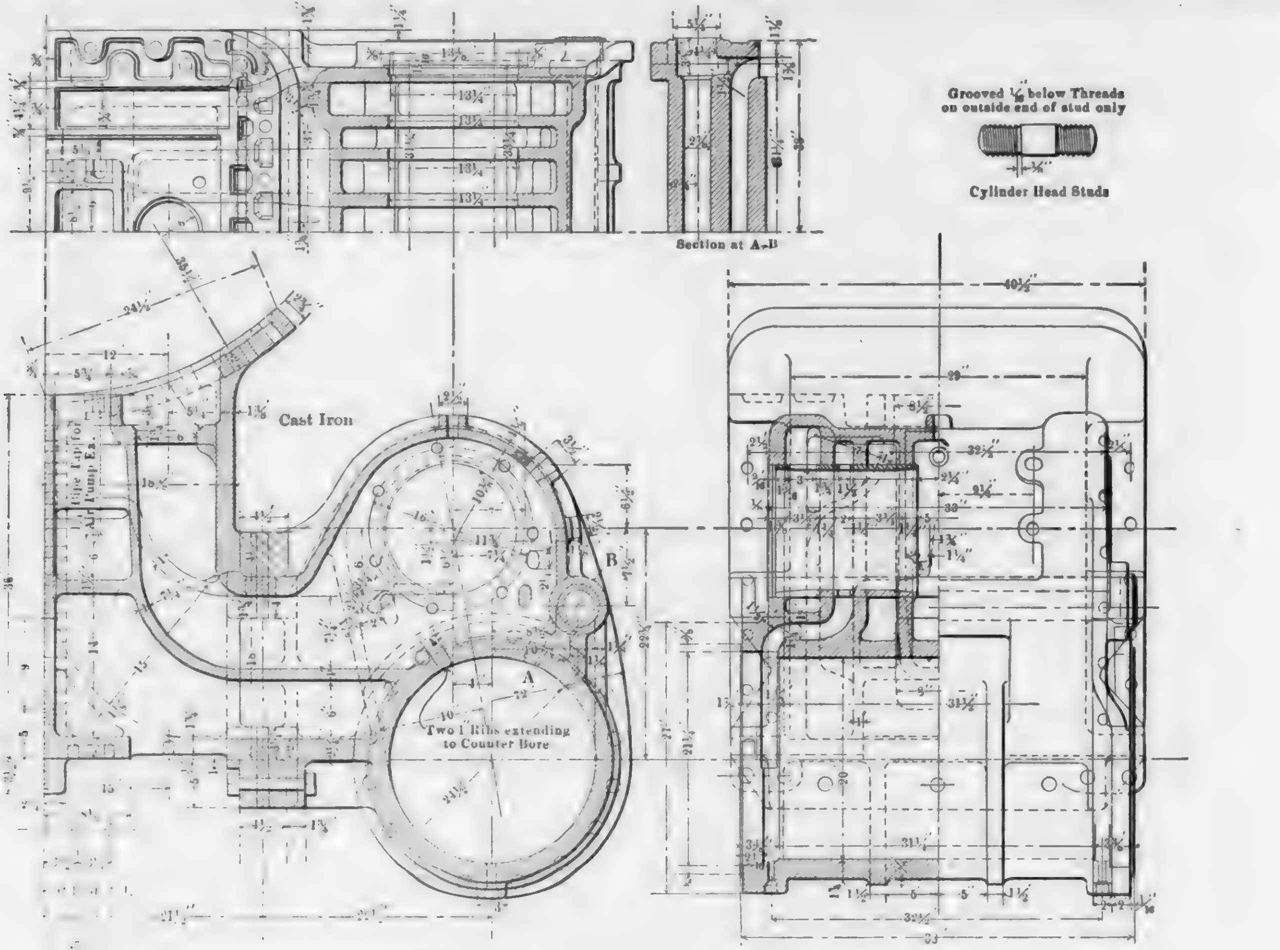


TRUCK WHEEL, PASSENGER ENGINES.

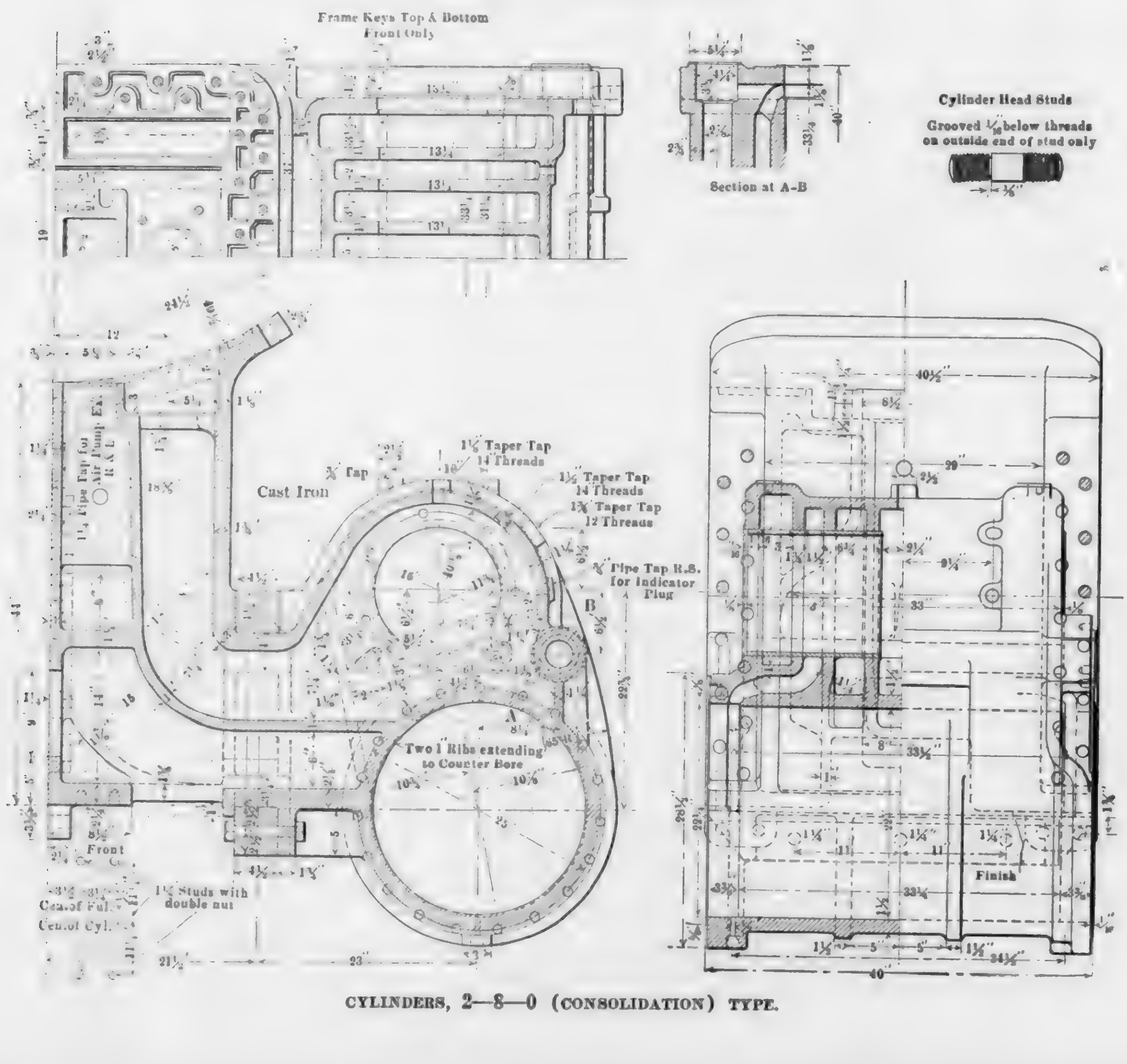


ECCENTRICS FOR ALL ENGINES.

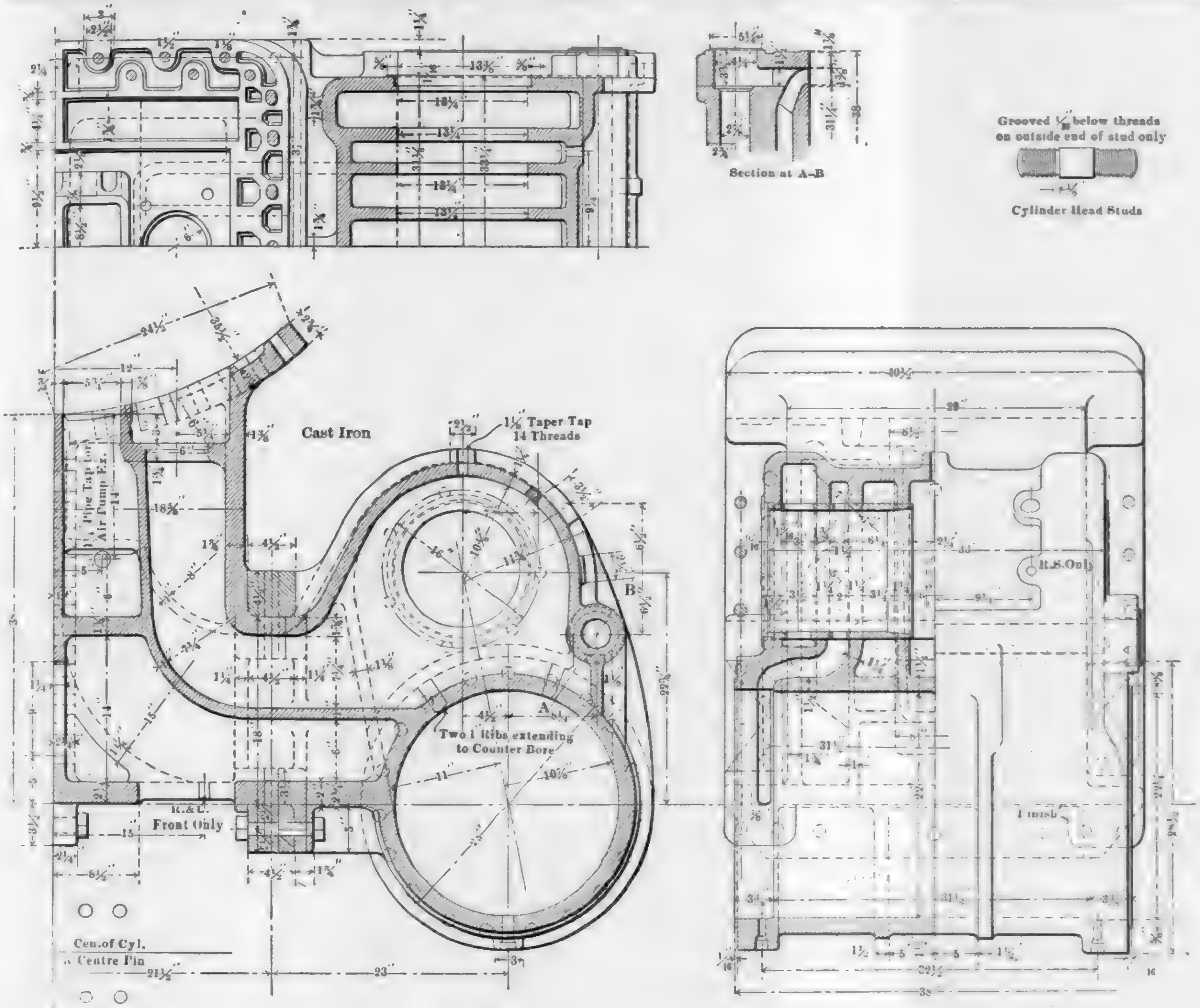
COMMON LOCOMOTIVE STANDARDS—HARRIMAN LINES.



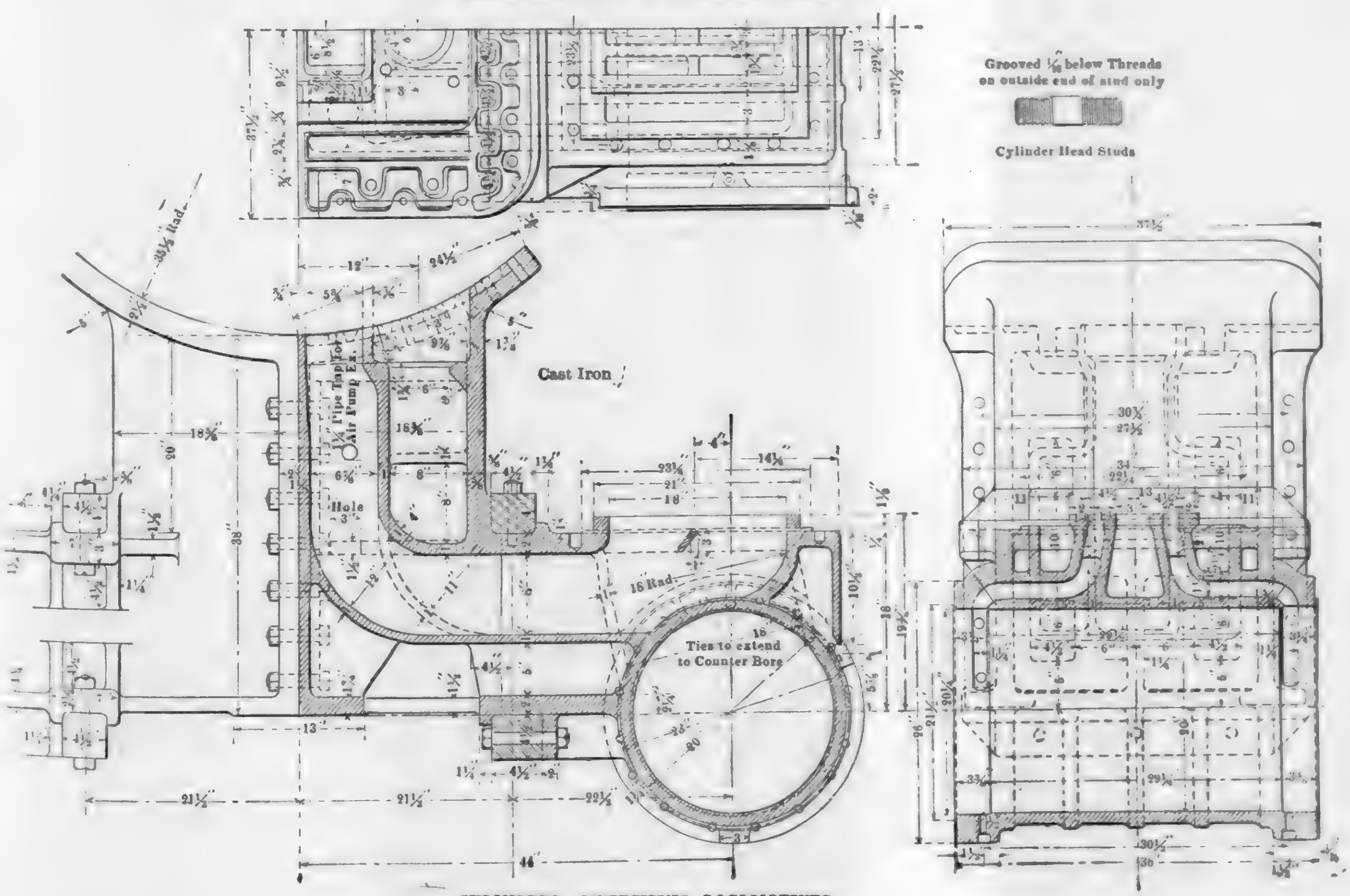
CYLINDERS, 4—4—2 (ATLANTIC) TYPE.



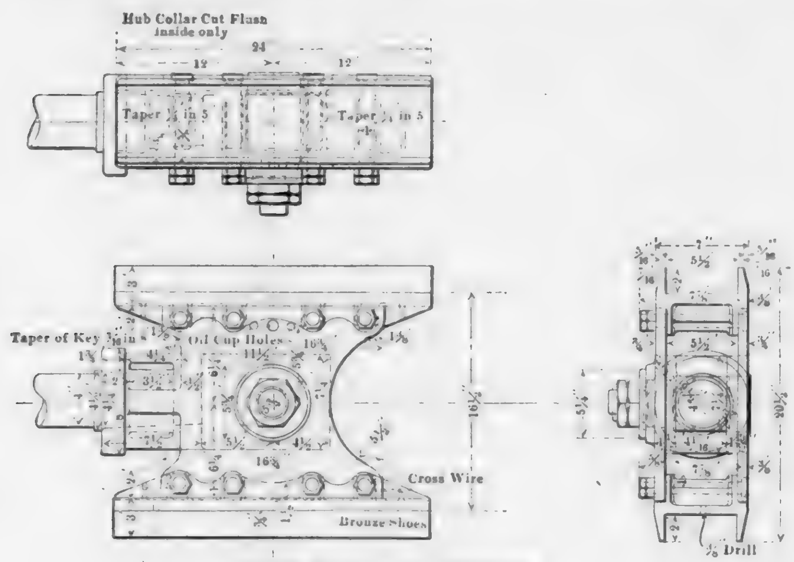
CYLINDERS, 2—8—0 (CONSOLIDATION) TYPE.



CYLINDERS 4—6—2 (PACIFIC) TYPE.



CYLINDERS, SWITCHING LOCOMOTIVES.

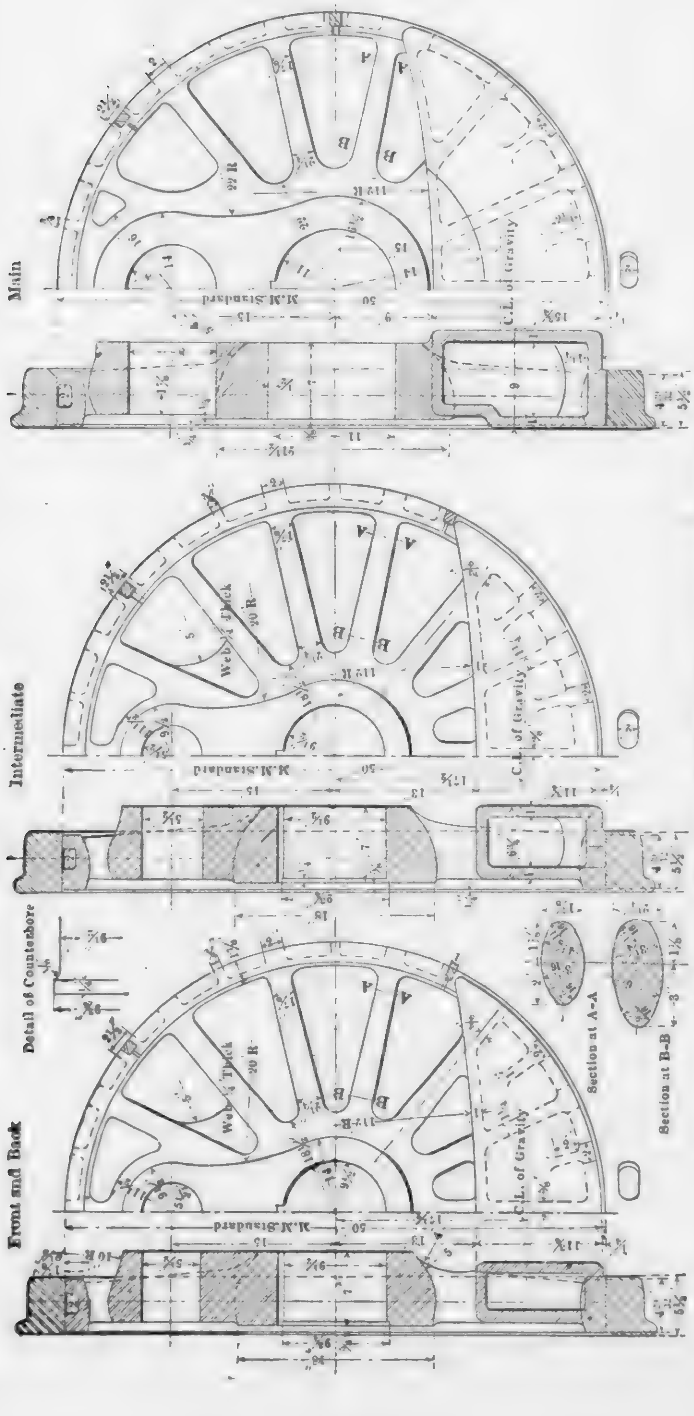


CROSS-HEADS, ALL ENGINES.

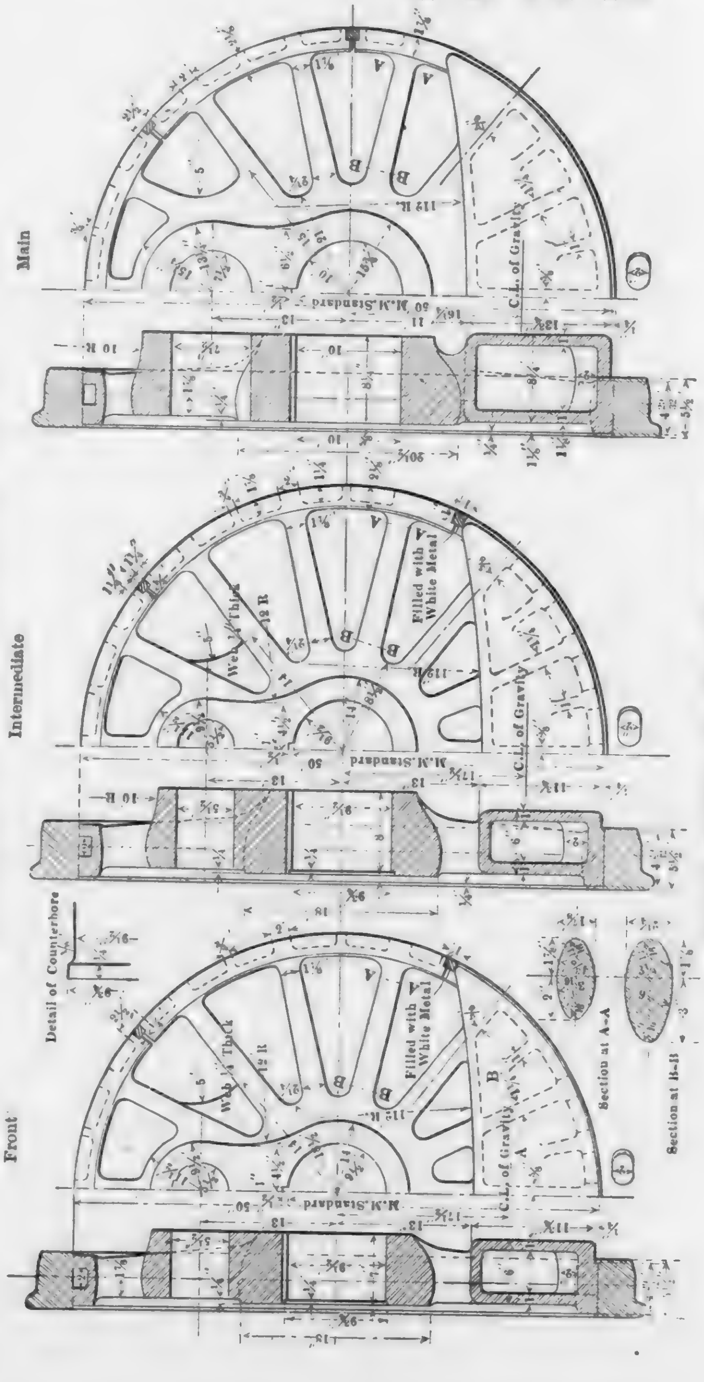
COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

NORMAL WEIGHTS OF DRIVING WHEELS.

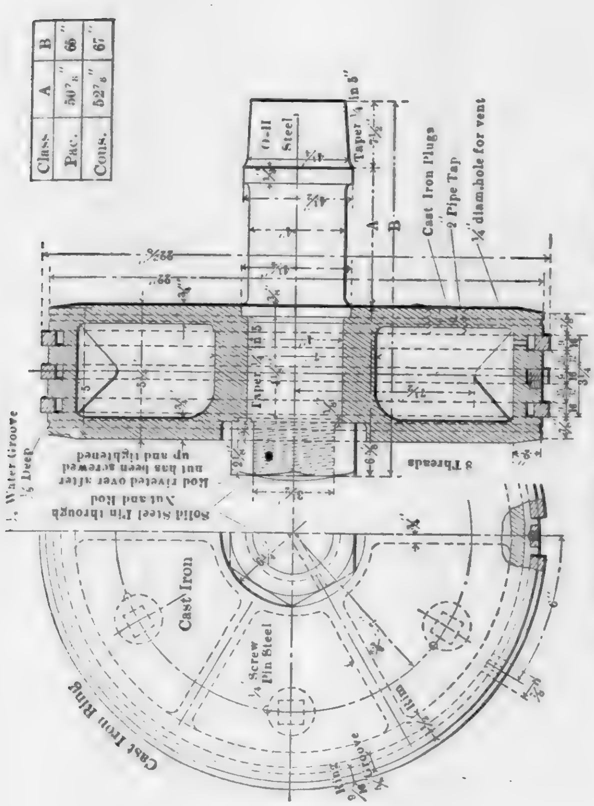
	Centre Only. Rough	Centre Only. Finished	Tire Only. Rough	Tire Only. Finished	Estimated Weight of Crank Pin Hub	Lead Filling	Total Weight of Completed Balance	Finished Wheel with Balance
ATLANTIC TYPE.								
Main	2840	2500	1480	1419	180	390	658	4366
Front	2800	2450	1480	1419	139	128	332	4059
PACIFIC TYPE.								
F. & B.	2430	2191	1400	1339	106	53	326	3620
Main	2710	2321	1400	1339	152	456	840	4210
CONSOLIDATION.								
F. & B.	1895	1487	1015	998	140	270	509	2755
Inter.	1960	1509	1015	998	140	348	635	2855
Main	2250	1825	1015	998	235	825	1392	3648
SWITCHER.								
Front	1868	1468	1015	998	102	174	425	2640
Inter.	1894	1494	1015	998	118	315	566	2807
Main	2217	1767	1015	998	190	625	1044	3390



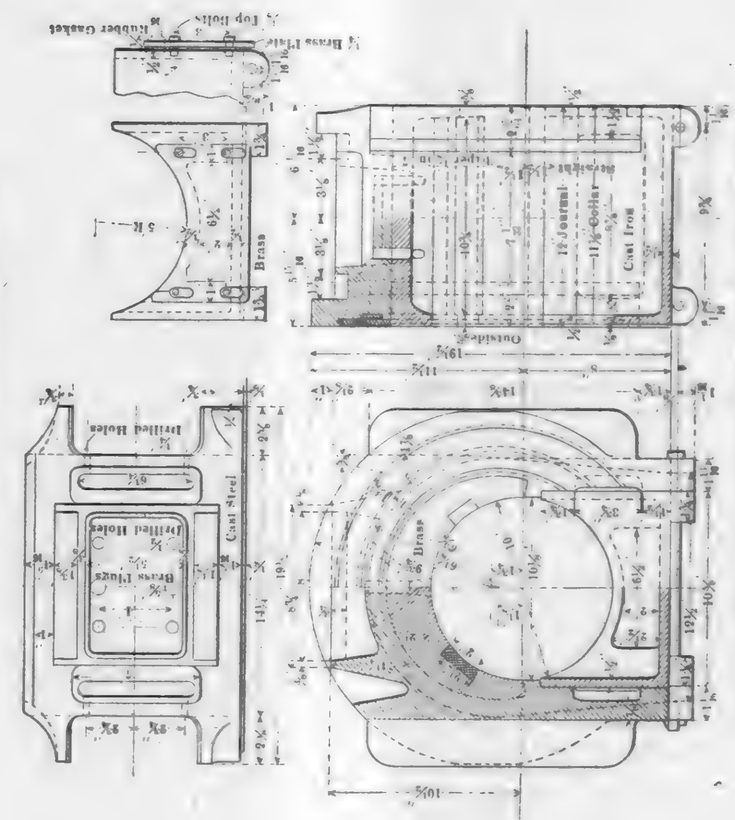
DRIVING WHEELS, 2—8—0 (CONSOLIDATION) TYPE.



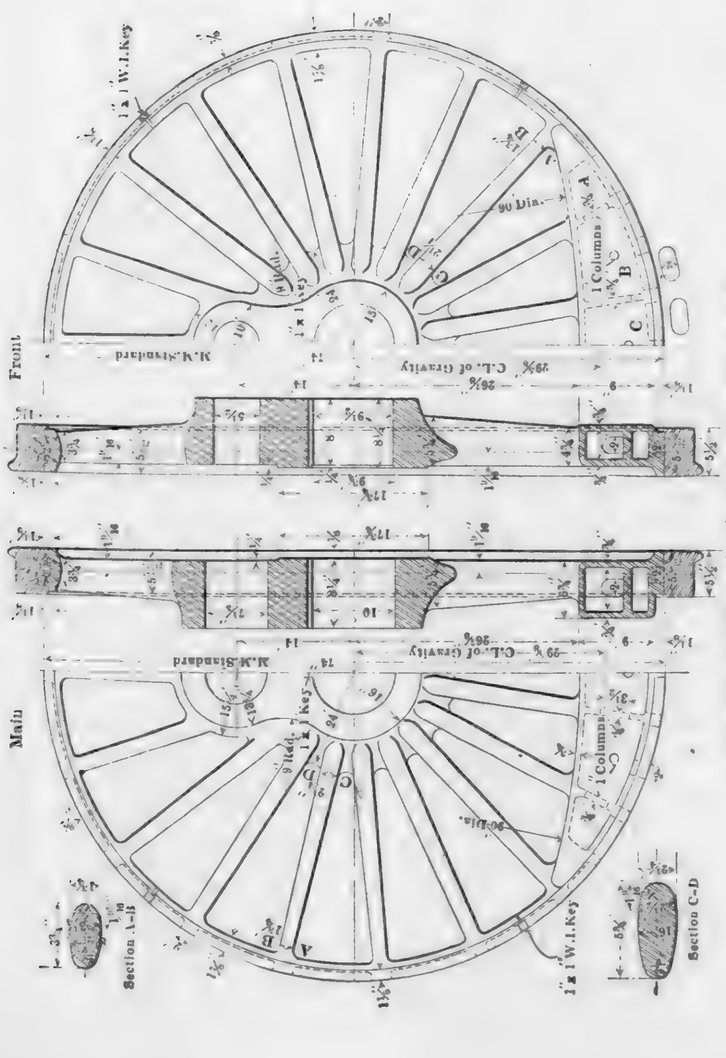
DRIVING WHEELS, SWITCHING LOCOMOTIVES.



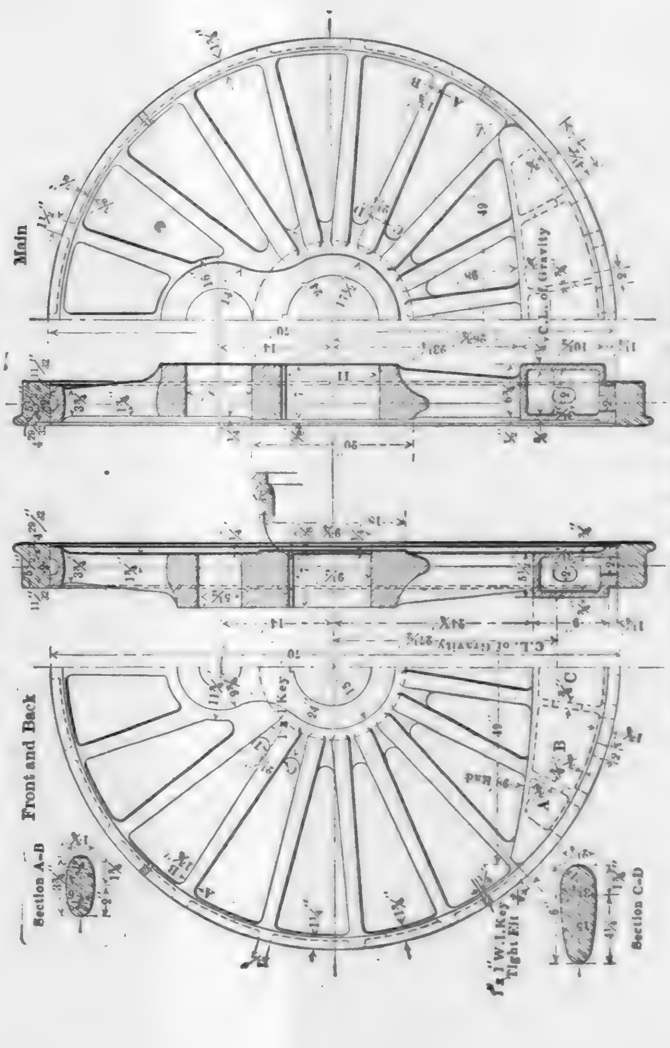
PISTON—PACIFIC AND CONSOLIDATION TYPES.



MAIN DRIVING BOX—CONSOLIDATION AND PACIFIC TYPES.



DRIVING WHEELS, 4—4—2 (ATLANTIC) TYPE.



DRIVING WHEELS 4—6—2 (PACIFIC) TYPE.

ton drawings suffice for all engines. The Atlantic type and switcher take 20-in. pistons and the Consolidation and Pacific types 22-in., the piston rods being all 4 ins. in diameter and vary in length only. The pistons are of cast iron 5¼ ins. thick, each with three cast iron packing rings. The pistons for the Consolidation and Pacific types are illustrated, the only difference between these and the one for the Atlantic type and switcher being in the diameter of the piston and the length of the piston rod.

Cylinders.—As already stated, all road engines have the same piston valve and valve stem packing and the same piston rod packing, and the cylinders are arranged to bring the centers of the valves at the same distance from the centers of the frames. All of these cylinders are provided with a modification of the Sheedy circulating pipe, provided for in the cylinder casting itself. All the cylinders have the same exhaust and steam pipe seats and the same length of saddle fit except the switchers which have a lighter saddle. The exhaust pipes are held by six studs and each steam pipe by four studs. All the road engines are double bolted all around. The cylinders are all arranged for 43-in. frame spacings and for the same cross section of frames.

These details give evidence of unusual care in designing, the chief purpose being to adhere to common standard construction without sacrifice of other factors to secure this result.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.

Other details will be presented later.

REPORT OF COMMITTEE ON FREIGHT EQUIPMENT.

Rock Island Company.

II.

(*For previous article see page* 153.)

Editor's Note.—This study of the car equipment of the Rock Island and 'Frisco systems deals first with the composition of the equipment, its age, cost and present value. This is followed by a statement in detail concerning the condition of the equipment, the recommendations as to retirement or improvement. In this portion of the report various equipment parts and devices, which have given good service, are recommended. A large proportion of the report is occupied by a statement concerning all the various groups of cars now in service. The following section deals with numbering and classification, and the report closes with recommended designs for new equipment. The size of the report and the large variety of different classes of cars forming the equipment of a combination of roads, together with the very large investment in car equipment are impressive features of this unique document. No argument could possibly be stronger to show the necessity from a commercial standpoint of standardization. Abstracts from the report follow:

It is the opinion of the committee, based on the information given in these diagrams, and actual observation of the equipment, that the limit of safe, useful and economical operation of wooden cars is reached at the ages given below:

Box cars	18 years
Furniture cars	18 years
Refrigerator cars	12 years
Fruit cars	14 years
Stock cars	14 years
Coal cars	14 years
Flat cars	14 years
Ballast cars	12 years

and that an annual depreciation, based on the above terms of years and allowing for the value of the scrap material in the cars, should be charged off, so that when the limit is reached the car can be retired from revenue service and either be destroyed or used in yard or work train srvice only. Attention is called to the fact that the average of these limits is practically the same as established by the M. C. B. Association, viz., 16 years.

To find the value of a car at any age within the limits above given, subtract from the original cost the scrap value. Multiply this result by the percentage shown opposite the age, and add the scrap value.

In calculating the value of the caboose cars, the age limit has been take at 25 years.

Tables give the number of cars in service October 1st, 1904, arranged in series, showing in each case the car numbers and initials, length, capacity and age, also a list of the principal features of construction, together with the recommendation of the committee as to what should be done for its betterment, if 60,000 lbs. capacity or over, or the limit of expenditure, if less than 60,000 lbs., which, if the condition of the car indicates must be exceeded, will determine that it shall be retired from active service.

In determining the limits the committee was governed by not only the age and condition of the cars, but by the strength of the body bolsters, which are the foundations upon which the superstructure is carried, and which when weak are the cause of excessive wear of wheel flanges and also derailments, by excessive friction on the truck side bearings. (These limits vary from $10 to $80, depending upon the capacity and the general character of the equipment and construction. The tables are omitted.—Editor.)

The limit is made higher for cars equipped with the American continuous draft rigging, because of the fact that if it is thought advisable to apply an improved type of draft, it must of necessity be applied to both ends of the car at the same time, whereas in the case of a car equipped with a single spring draft, the new type may be applied to one end at a time.

VALUATION OF CAR EQUIPMENT.

	Box and Furniture.		Fruit, Stock, Coal and Flat.		Refrigerator and Ballast.	
Years.	Rate.	Percentage.	Rate.	Percentage.	Rate.	Percentage.
1	5.5	.945	7	.93	8	.92
2	5.5	.890	7	.86	8	.84
3	5.5	.835	7	.79	8	.76
4	5.5	.780	7	.72	8	.68
5	5.5	.725	7	.65	8	.60
6	5.5	.670	7	.58	8	.52
7	5.5	.615	7	.51	8	.44
8	5.5	.560	7	.44	8	.36
9	5.5	.505	7	.37	8	.28
10	5.5	.450	7	.30	8	.20
11	5.5	.395	7	.23	8	.12
12	5.5	.340	7	.16	8	.04
13	5.5	.285	7	.09		
14	5.5	.230	7	.02		
15	5.5	.175				
16	5.5	.120				
17	5.5	.065				
18	5.5	.010				

Example: A box car costing originally $660 has a scrap value of $110. What is it worth when 16 years old?

Original cost	$660
Deduct scrap value	110
	$550
Percentage	.12
	66.00
Add scrap value	110.00

$176.00 value at 16 years.

These recommendations as to the limit of expenditure are only general, and intended to show the relative worth of the cars, and are subject to modification in the case of such cars as have been rebuilt within five years, upon inspection as outlined hereafter, and are intended to apply only to the bodies of the cars, and they do not include the cost of running repairs to the trucks, couplers or air-brakes. The intent in recommending limits is that these amounts may be expended on such cars when they come to the shops for repairs after a given date, for instance, January 1, 1905, and should they again come to the shop for repairs to an equal amount within six months after leaving the shop, they should be retired at once. To assist in determining the amount of expenditure required for repairs, the committee suggests the preparation of schedules for each class of car, showing the cost of the various parts, and an example showing its application.

When a car is received at the shops requiring repairs in excess of the limit, report should be made at once to the general superintendent of motive power and authority obtained

for its retirement, and in recommending a car for retirement the following points should be given consideration:

First—The design, capacity and age.

Second—The condition of the longitudinal sills, bolsters, draft rigging and trucks.

Third—Its availability for some other class of service, for instance, by converting a stock car into a coke car, or a gondola car into a flat car. In each case recommended for retirement careful inspection should be made by some competent person detailed by the general superintendent of motive power to determine the action to be taken, and the decision reached should be immediately noted in the historical record.

The committee, while recommending the maintenance of wooden cars of 60,000 lbs. and 80,000 lbs. capacity, does not recommend their perpetuation beyond the age limit mentioned, nor after the time when the cost of repairs exceeds 60 per cent. of their depreciated value at the time such repairs become necessary; the intent of this recommendation being that all wooden cars should be retired when they reach their limit of usefulness, and be replaced by steel frame cars, thus gradually bringing the system to a single standard for each class.

The portions of the higher capacity cars most liable to failure are found to be the body bolsters, truck bolsters, draft attachments, door fixtures, brake beams, coal car sides, the end framing, end lining and roofs of box and stock cars and the floors of open cars.

The committee recommends, in addition to the specific recommendations in the equipment list for the strengthening of such parts, that the floors of stock, coal and flat cars when renewed should be of material 2⅜ ins. thick, and the end lining of closed cars, when renewed, be made of material 1¾ ins. thick. The end framing of closed cars should be strengthened by the addition of horizontal truss rods, which in connection with the 1¾-in. end lining will reduce the liability to damage by the shifting of the load to a minimum.

It is also the opinion of the committee that one end door is sufficient for a closed car, and such cars as now have two should be changed whenever shopped for repairs.

The sides of coal cars are frequently weak by reason of the stakes being either too small in size or insufficient in number, and in such cases they should be strengthened by the application of braces and such additional stakes as may be required.

In many cases the cars are found to be equipped with excellent draft attachments, but with draft timbers insufficiently secured. In such cases anchor rods should be applied, which will reduce the strain on the vertical bolts securing the draft timbers to the sills, and eliminate damage from loose timbers.

The door fixtures now in use on the equipment are mostly of such a design as to permit the shifting of the doors, when switching, unless closed and locked. This shifting permits the doors to pound against the stops, with the result that either the hangers become loose and the door drops off, or the stops come off and the door runs off at the end of the track, and is finally either lost or damaged by being hit by passing cars, the latter being a frequent cause of derailment of trains. The fixtures recommended have been designed in such a manner as to prevent this shifting, and when the hangers are secured to the doors by bolts, the door cannot be dislodged.

Many of the bolsters (cast steel excepted) are fitted either with pressed steel or malleable iron center plates, which are too small in bearing surface to have the strength to resist the pressure of the load, and therefore fail by punching out the bottom plate, or in which the pressure per square inch due to the load causes excessive friction, and consequently excessive flange pressure on curves by reason of the inability of the truck to turn easily under the car, which, of course, is productive of excessive flange wear on wheels and rails and also derailments on curves. The committee recommends that in such cases the center plates as they fail, or are found to bind on curves, be replaced by cast steel center plates having a sufficiently large area to bring the friction within the proper limits for the material used.

(To be concluded.)

SOUTH LOUISVILLE SHOPS.

LOUISVILLE & NASHVILLE RAILROAD.

This plant occupies a tract of 55 acres, 12½ of which are under roof. While figures on capacity are usually somewhat elastic, it was intended for the complete maintenance of 450 locomotives besides the building of a small number each year. The car department was designed to repair 100 freight cars per day, for complete maintenance of 450 passenger cars, the building of 15 new freight cars per day and the building of about 25 passenger cars per year. By the extension of buildings and arrangement of departments an extension of one-third of the present size of the plant is provided for. The plans were most carefully worked out by Mr. Theodore H. Curtis, superintendent of machinery of the road, from whom the plan and descriptive information has been received.

The plan and operation of these shops centered in the use of the most modern machinery and means of handling material, as well as the equipment which comes into these shops for repairs, to the best advantage. The three principal features of the plan are:

First—A long, pointed, fish-shaped yard extending north and south, and being relatively narrow east and west.

Second—A wide, high-speed transfer table passing east and west transversely nearly across the yard group.

Third—A high-speed, stockyard, overhead travelling crane running from the north side of the transfer table, a distance of 1,000 ft., the crane having a span of 40 ft., a clearance of 15 ft. and a bridge speed of 1,000 ft. per minute.

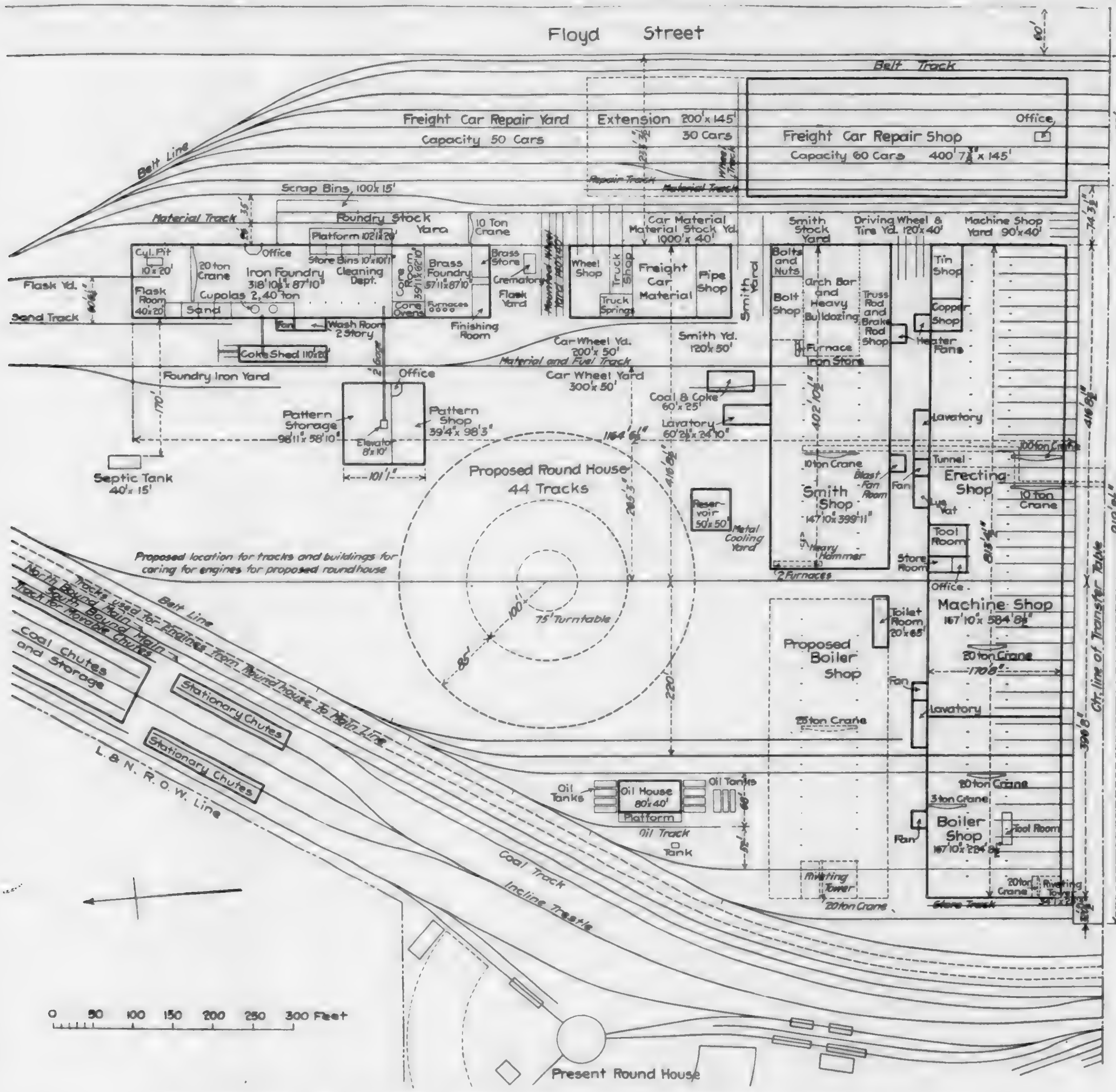
The grouping of the buildings, therefore, was determined largely by the problem of transporting material.

The central figure of the layout is an L-shaped avenue of transportation, formed by the transfer table and the stockyard crane. The metal parts are handled by lifting and transporting overhead, the wooden parts being transported horizontally on low cars with as little lifting as possible.

The metal working buildings, such as the locomotive, erecting, machine and boiler shops, the smith shop, wheel, and axle shop and the foundry, all connect directly to the stockyard crane, while the wood-working shops, such as the planing mill, cabinet shop, coach shop, new freight car shop and freight car repair shop, all border upon the transfer table. The metal parts enter the shop yards from the north and lumber from the south. Each operation on metals is in a southerly movement, passing into the metal working shops and under rapidly moving travelling overhead cranes. These cranes move in an easterly and westerly direction, forming direct connection with the stockyard crane. Each building receives its material from and delivers its product to the stockyard crane, and metal purchased in large quantities is delivered to this crane at its north end, this crane being available because of the grouping of the buildings for handling all material, whether manufactured at the shops or purchased outside, this being the receiving and distributing medium.

The wood in process of manufacture moves northward through the dry kilns or planing mill, and is delivered to the transfer table for distribution. The table also connects with the stockyard crane, and therefore becomes a part of the general receiving and distributing agent for all materials. By this arrangement metal parts move south and wood north, both using the L-shape avenue of transportation to distribute quickly and by mechanical means all the materials used at the plant. Hand labor is avoided by the mechanical equipment. While the transfer table is used generally for the product from the planing mill, it also may aid in an important way in getting material to the locomotive shops. This transfer table has a speed of 1,000 ft. per minute.

The track arrangement is such that switching may be done upon either side of the plant, and by use of the transfer table narrow-gauge yard tracks with turn-tables are avoided. Back of the planing mill is a sill yard, convenient to the dry kiln and south of the car shop buildings is a large yard with tracks at 60 ft. centers with a capacity of ten million ft. of lumber.



NEW LOCOMOTIVE AND CAR SHOPS, SOUTH LOUISVILLE, KY.—LOUISVILLE & NASHVILLE RAILROAD.

This lumber is handled on cars which are 2 ft. high, this height being adopted for all platforms in the lumber department, to avoid lifting and dropping heavy material. Lumber is loaded on kiln cars and kiln cars and lumber are transported on yard cars to the dry kiln, the kiln car passing through the dry kiln and again on to the yard car, and transported into the lumber shed or to the planing mill machines with only one handling of the lumber.

In the plan the crane service in the locomotive shop buildings is indicated. The plant has ten high-speed power cranes for rapid handling of material. The locomotive shop has transverse tracks served by the transfer table outside and by a 100-ton and a 10-ton electric overhead travelling crane inside. A careful study of the track arrangement will show that it would be impossible to tie up this plant by the failure of the cranes or transfer table.

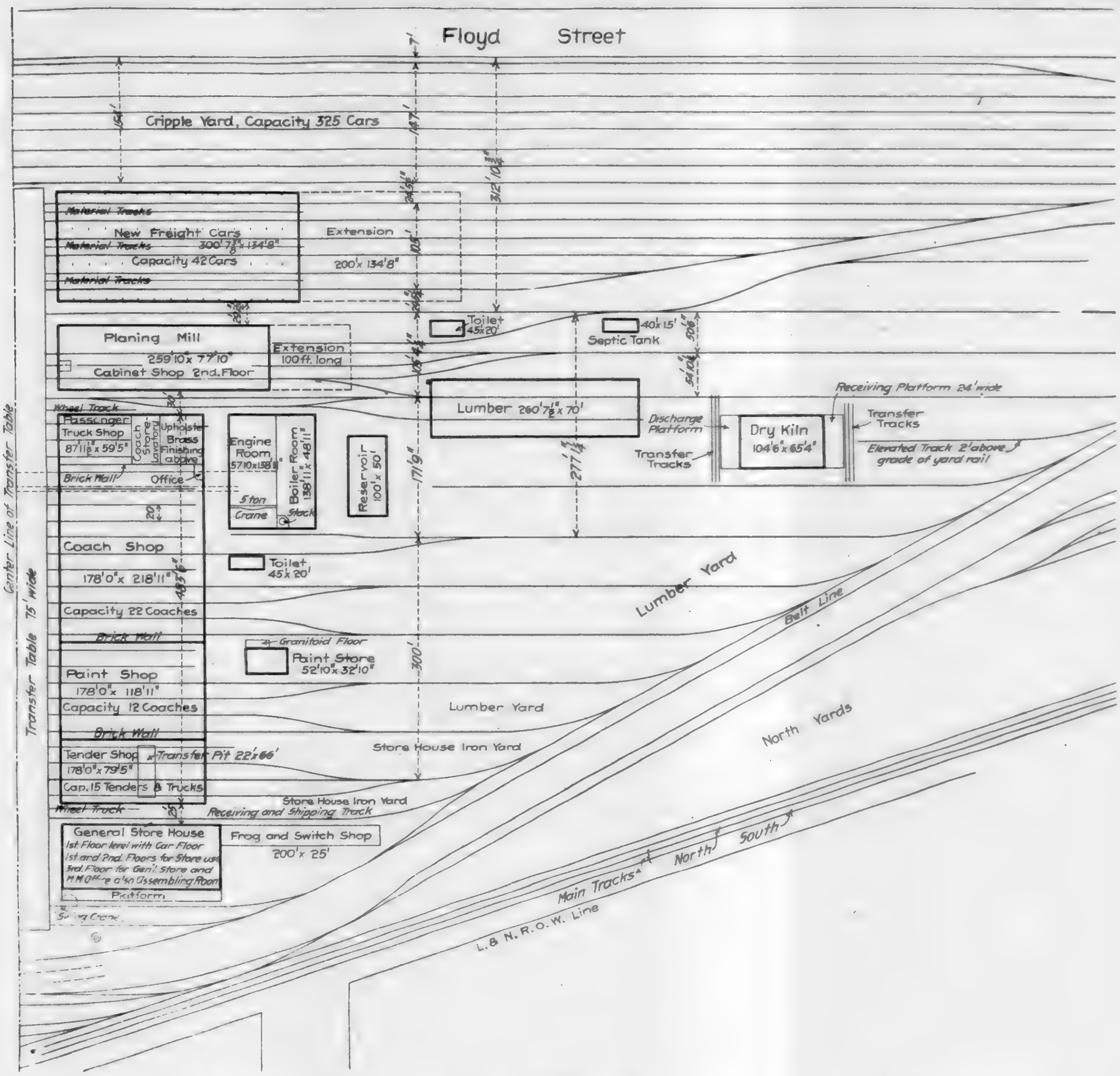
The power house was located near the planing mill in order to utilize the shavings from that department. As a part of the plan a 44-stall roundhouse is provided for, as indicated on the plan.

Climatic conditions were carefully considered in order to secure north light and avoid sunlight in the buildings, this being exceedingly important in the latitude of Kentucky. This arrangement takes advantage of the Southern breezes, which constitute an important factor in the hot season at Louisville.

A description of the departments in detail must be reserved until later. This plant was laid out by Mr. Theodore H. Curtis personally. The shop buildings were erected under the direction of the engineering department of the road, under the approval of Mr. Curtis. A thorough description of this plant will be presented when its organization and operation are complete.

A MATTER OF EDUCATION.

Progress in any other department of engineering during the past ten years has never been as great as that connected with the American locomotive. Locomotives have not only increased in size and power, but the methods of operation have changed radically in that time. In the extraordinary stress of business, requiring every available locomotive, practically all the time, pooling has become general, and the men operating locomotives have lost individual responsibility for and interest in the machines they run. Individual coal records were formerly important factors. Now they are not, and the



NEW LOCOMOTIVE AND CAR SHOPS, SOUTH LOUISVILLE, KY.—LOUISVILLE & NASHVILLE RAILROAD.

present tendency is toward complete abandonment of records which formerly tended to cause emulation among engineers for fuel saving. In fact, the prevailing types of coal chutes do not provide for either weighing or measuring the coal. When locomotives were small, the fuel question was important, from the standpoint of operating economy. With the present large engines economy is not less but more important, because the quantities are larger. But now we face another question. Compounding was introduced for reasons of economy. It was continued for reasons of capacity. American railroads adopt superheating and four-cylinder balanced compounding—not for reasons of economy, but for increased capacity.

CAPACITY is the goal locomotive people are striving for, and they have made much progress, but they have forgotten the factor which lies nearest at hand. They have forgotten the human element in control of the locomotive, which presents more possibilities than any other. The difference between the work of the best and the average man on a locomotive represents more to the road than the economies to be obtained from the best fuel-saving appliance or invention ever brought out. When it is appreciated that fuel saved because it is not burned affects the capacity of the locomotive, and increases the efficiency of heating surface, as does compounding and superheating, we shall pay more attention to the men who run the engines. It will not be disputed that, as a rule, the firemen who throw 3,000 lbs. of coal per hour receive less careful training and less preparation for their work than those who were required to throw but 1,000 lbs., in the past years. If American firemen and engineers were as efficient and as interested, personally and financially, in saving coal as are those of England and France, our locomotives would not need to be quite as big as they must be under our conditions to-day. We cannot take a backward step in size and power, but we must take a forward step in locomotive operation and pause a little in the march toward greater power.

An emergency may justify putting a man on a freight engine as fireman after only three days' instruction, but nothing can justify an average of only a week of training for a number of new firemen on a certain road last winter.

In order to ascertain whether the situation and possibilities are understood, a number of the highest railway officials in the country were asked by the editor the following questions:

"The president of one of our largest railroads has stated that he cannot secure as good men as engineers and firemen

of 100-ton engines as he had when 50-ton engines were considered large ones.

1. Do you find this true in your experience, and, if so, does it apply to other men on the road and in the shops?

2. Is it not necessary for the railroads to look after recruiting methods more carefully and to undertake better methods of selecting and preparing men for their work?

3. Is it advisable for railroads to undertake systematic education of the men after they enter the service?

4. Are you worried as to where you can secure good men in times of heavy business?"

Because these questions concern the labor question, most of the replies were guarded by a request that the author's name should not be given. For this reason all of the names are withheld. The letters come from the highest and best-known railroad officers in this country, representing over 80,000 miles of railroads. They indicate that some do and some do not fully appreciate the importance of the personal element in locomotive operation. That its importance is appreciated at all is encouraging. Abstracts from a few of the letters follow, the paragraphs being numbered to correspond with the questions stated above.

FROM A GENERAL MANAGER.

1. As a rule railroads are not securing as capable firemen at the present time as they were a few years ago when fifty-ton engines were considered large ones. For this same reason the engineers who are promoted from firemen are not as capable as the engineers who entered the service of roads several years ago. I do not believe this applies to men in the shops.

2. I believe we all realize the necessity of giving more attention to the employment of new men entering the service, especially firemen and brakemen, and, as a matter of fact, many roads are instituting a more rigid system of selecting and promoting men for their work.

3. We believe it is advisable for railroads to undertake a systematic education of men after they enter the service.

4. Owing to the very heavy and sudden increase of business on railroads throughout the country, it is a difficult matter to secure good men, and, to a certain extent, it is a source of great worry.

FROM A PRESIDENT.

1. It is within the recollection of men now in railway service (myself among the number) when firing light locomotives was a vocation that did not require men of extraordinary strength—in fact, I have known men of sedentary occupations to enter upon that of firemen with the view of regaining their health. With the advent of the large engine the duties of the fireman became so physically arduous that it is not now a question of brain, but one of brawn. We have, therefore, developed a set of men who are stronger physically, regardless of their mental aptness, and, as a whole, the men of to-day are not as good as the men of twenty-five years ago.

2. It is necessary for railroads to look after recruiting methods and to undertake better methods of selecting proper men for their work.

3. It is advisable for railroads to undertake the systematic education of the men after they enter the service.

4. Railroads which traverse thickly settled portions of the country have no trouble in procuring men, but roads which have outlying branches or run through sparsely settled country must have trouble in that direction. Taking into consideration, however, the fact that there are a million or more men employed on railroads in the United States (more or less of them floating about), for obvious reasons, it is quite possible to obtain skilled men to bridge over any ordinary or temporary increase in business.

FROM A SUPERINTENDENT OF MOTIVE POWER.

1. Either the requirements of the service have grown so rapidly that the average man is not keeping pace with them, or else we are not getting as good men. As a rule, our service is not as good, and the men do not seem to take the same interest in their work as they did when lighter equipment was used. I attribute this condition largely to the fact that each year brings out a better educated lot of young men. The work of firing a locomotive is hard and unpleasant, and young men will seek other positions and oftentimes take a lower rate of wages in order to avoid the hard and unpleasant work.

2. Railroads will have to look after their recruiting methods more carefully and make their positions more attractive in order to maintain the high standard of service which more modern conditions require.

3. I believe that railroads must undertake a systematic education of the men and make wages and conditions sufficiently attractive to draw a better class of men into the service.

4. In our experience, when business is heavy we are forced to accept the services of men that we would not have with us under any circumstances were it possible to get along without them.

These views may seem a little radical, but any railroad man who is in close touch with practical operation, if honest, will endorse them.

FROM A PRESIDENT.

1. The number of engines required to handle the increased business has increased in a greater ratio than it has been possible to drill and train enginemen, and, in consequence, a larger proportion of younger and less experienced men are forced into this service. Another reason, probably, why this condition exists is, as you know, on account of railroading being more exacting than it has been in past years, and, for this reason, men who might be considered first-class some years ago are not so considered at the present day.

2. Unquestionably, yes; we are doing everything we can in this direction.

3. Indirectly. This, however, should be carefully handled to avoid what might be termed "pauperizing" men in the matter of training and education. They are too prone to rely upon statements of instructors and fall back upon them in case of bad service.

4. Yes. This is a serious question with us.

FROM A PRESIDENT.

1. I do not think our experience has been exactly the same as that of the president of the railroad you quote as saying that it is impossible to secure as good men as engineers and firemen for 100-ton engines as for the 50-ton engines formerly used in our freight service. When we first began the introduction of heavier engines, something like five years ago, we did experience considerable difficulty through our enginemen, who had been used to the old and larger power with which we were then equipped, not doing as well with the new and heavier engines, and it took some time for our men to become accustomed to the heavier power, and we had to carry on a campaign of education for some time in order to thoroughly fit our men to handle the new power to the best advantage.

2. It is undoubtedly very necessary that the railroads hiring new men for service on their engines should be more careful in the selection of bright, intelligent young men, who, after their experience as firemen, will be better able to assume the duties of engineers than under conditions that existed fifteen or twenty years ago. I think, further more, it is very desirable for railroads to undertake to systematically educate the men who enter their service in the lower ranks so that they may be fitted for the more responsible duties that they will be called upon to perform in the event they are promoted to better positions. We are not particularly worried as to where we can secure good men in times of heavy business. It is a fact, however, that such men are not so readily available for employment when business increases steadily and sharply as formerly. I think the difficulty some of the railroads are having in securing men to handle their heavy power satisfactorily is due to a combination of conditions something like the following:

A considerable percentage of the older and more experienced engineers are dropping out of the railway service each year, either through death or disability on account of their age and the hard, trying service they have been subjected to as engineers. The services of a larger percentage of the balance of the old, experienced engineers are required to handle the increased number of passenger and preferred freight runs, leaving the handling of the heavy freight and switching power to the new men and those of the least experience, and these engines are more difficult and complicated to handle than the smaller and lighter power formerly used in freight service and to some extent still in passenger service. It seems to me some such reasons as these, instead of those suggested in your letter to me, are the ones which seem to indicate that the railroads are not able now to get the same service as formerly out of the enginemen on their new heavy power.

FROM A VICE-PRESIDENT.

1. The 100-ton and larger locomotives require more intelligent handling by the engineer, more vigorous firing by the fireman, and more accurate fitting by mechanics in the shops—therefore, it is necessary to have a higher standard of employes. The work of the engineer and the mechanic in the shop is increased very little, if any, due to the engineer to-day being called upon to do practically no work about his locomotive, and the man in the shop having the modern facilities for doing his work. The fireman is called upon to handle a greater tonnage of fuel, but his work is confined merely to the time on the road, whereas in the past it was customary to call upon him to do a great deal of cleaning on the locomotive, which is now materially reduced. The work throughout, however, calls for more care and intelligence than in the past.

2. It would be to the advantage of all railroads to do as many are now doing, viz., use the greatest care in selecting and employing new men, and, in all cases, ascertain if they are physically all right, also if they have the ability of developing and assuming increased responsibilities.

3. I think it is money well spent for railroads to have a systematic education of the men, after they have entered the service, and insist upon their men availing themselves of such opportunities as are given, promoting the men by the progress they make in this particular, rather than by seniority.

4. Precautions have been made in the past to have a surplus of competent men available for a heavy run of business, when this takes place. This is very important.

FROM A SECOND VICE-PRESIDENT AND GENERAL MANAGER.

1. We do not have any more difficulty in securing as good engineers and firemen for the larger engines than we had in getting good men for the smaller power, but, on account of the changed conditions incident to the larger power and general prosperity of the country, we have had more difficulty in retaining them, and changes are, therefore, more frequent. As to the men in the shops, we have more difficulty in securing good men than we formerly had, not, however, due to the large power, but to the increased prosperity of the country.

2. Our recruiting and selecting methods have not been changed, but the educational and physical requirements are more rigidly enforced than formerly, and more care is exercised in preparing men for this work.

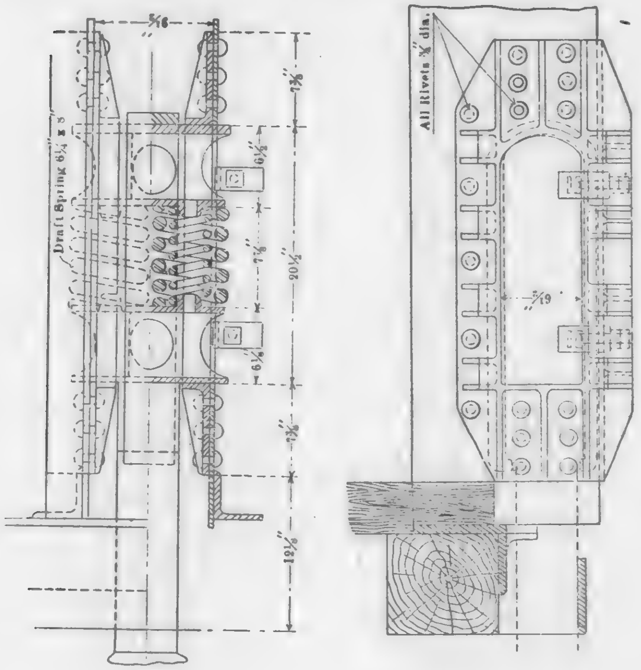
3. We find it necessary to undertake the systematic education and examination of enginemen after they enter the service, on the air brake and other appliances on locomotives.

4. We have had difficulty in getting men in times of heavy business, especially during the past two years, the greatest difficulty being in procuring a sufficient number of experienced engineers.

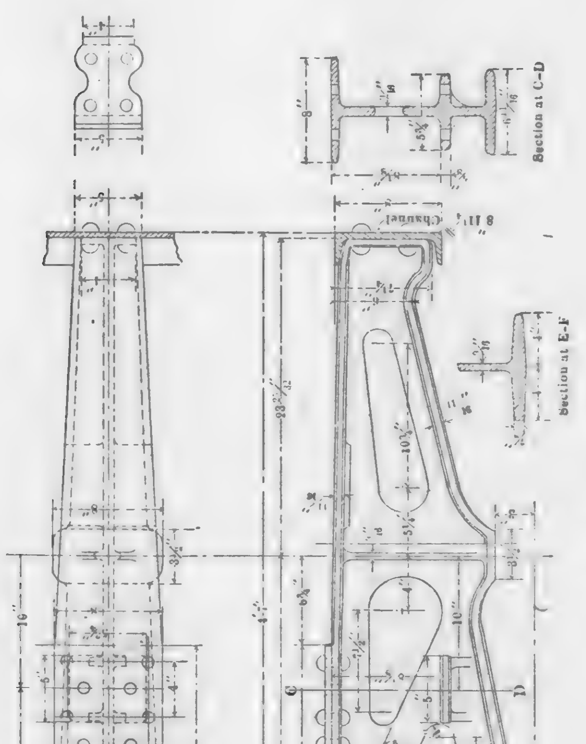
40-TON COMPOSITE HOPPER CARS.

SEABOARD AIR LINE RAILWAY.

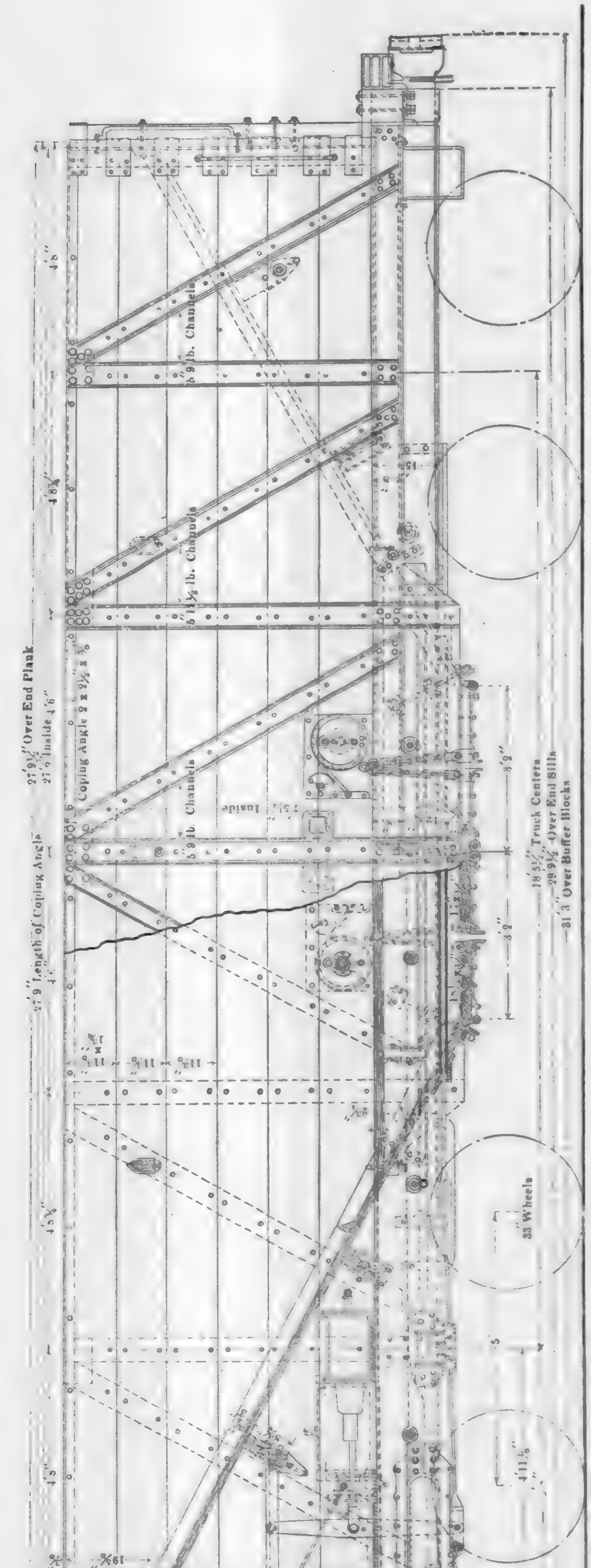
For coal traffic on the Seaboard Air Line a number of 40-ton composite cars have been constructed, using side frames to carry the load, the cars having been patterned after those of the same capacity which have been so successful on the Norfolk & Western Railway, and which are known as the design of Mr. C. A. Seley, formerly mechanical engineer of the Norfolk & Western. Mr. Seley's design is shown in this



DRAFT GEAR.



BODY BOLSTER CONSTRUCTION.



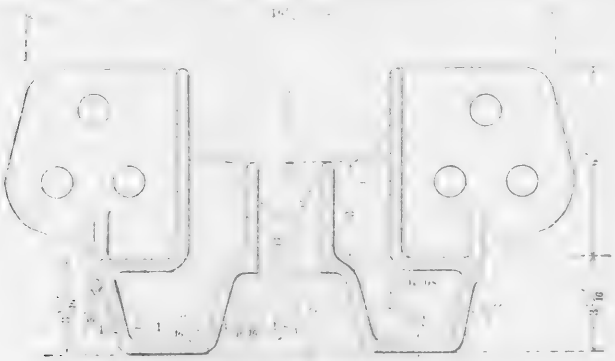
40-TON COMPOSITE HOPPER COAL CAR.—SEABOARD AIR LINE RAILWAY.

journal, in June, 1902, page 181. The general dimensions of the Seaboard Air Line cars are as follows:

Length over buffers	31 ft. 3 ins.
Length over end sills	27 ft. 9½ ins.
Length over body	27 ft. 9 ins.
Length inside	27 ft. 6 ins.
Width over sides	9 ft. 2 ins.
Width inside	8 ft. 9½ ins.
Height over hopper	7 ft. 5 ins.
Capacity	40 tons
Light weight	32,000 lbs.
Capacity, West Virginia coal	85,000 lbs.

The new features of this car are confined to the bolsters, draft gear and center plate construction. The bolsters are of steel castings, made in two parts with a coverplate connecting them over the center sills, the construction being such as to minimize the amount of fitting. The pressure at the bottom of these castings against the center sills is reduced by the large malleable iron center plate, which is of such a form as to take the load from the channels directly to the wearing surface of the plate.

The draft gear is of the twin spring type, the webs of the sills themselves being cut out to accommodate the gear. These holes are punched out in one operation. The cheek plates, which are of cast steel, are riveted to the sills, and the metal added in this manner more than compensates for the amount removed by the punching. The draft of the twin springs is brought to the vertical webs of the steel channels, so that the stresses of buffing and pulling are transmitted into the central web of the backbone of the car. These springs are easily inspected from the outside, and by removing the two clips on one side the draft rigging is easily drawn out of the coupler yoke for repairs. Mr. R. P. C. Sanderson, superintendent of motive power of the road, states that this gear has been in use on a number of cars, and has been entirely successful.



CENTER PLATE.

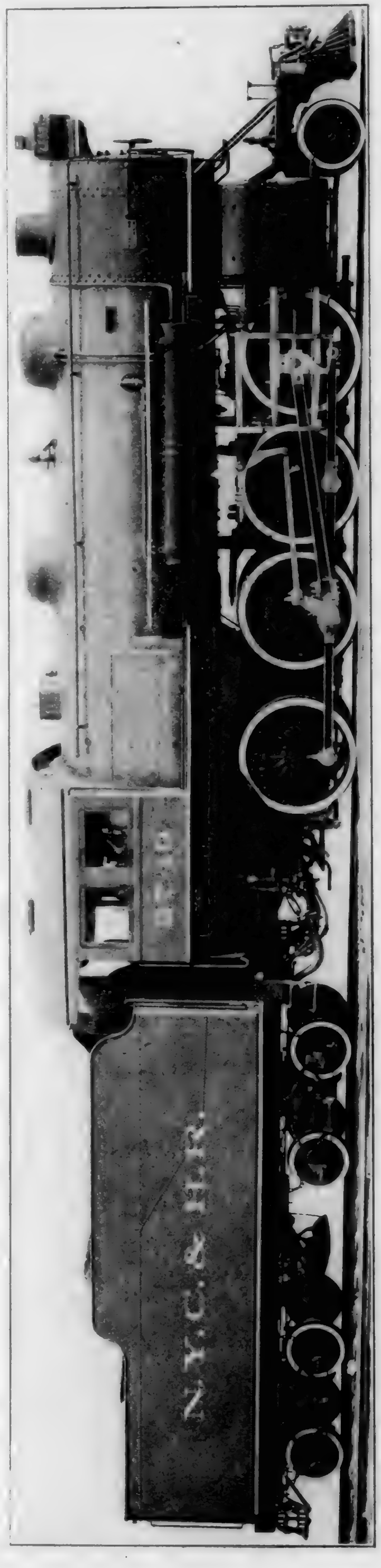
The adoption by the Norfolk & Western of this car construction is an additional mark of confidence in the design.

Descriptions of other cars of this kind may be found in this journal as follows: June, 1899, page 187; April, 1900, page 100; February, 1901, page 42; May, 1902, page 140; June, 1902, page 181; June, 1903, page 209; July, 1903, page 257.

We are indebted to Mr. Sanderson for these drawings.

Street Railways.—The mileage of the electric lines increased between 1890 and 1902 from 1,262 to 21,907, while there was a decrease for the lines operated by other motive power, the decrease being from 488 to 241 miles for cable lines, from 711 to 170 miles for steam lines, and from 5,662 to 259 miles for lines using animals for their motive power.

Efficiency of Motor Car Gearing.—French experiments on the efficiencies of gears fitted for motor car service give the following results in percentages for new and worn gears, respectively: Spur gearing, steel on steel, greased, exposed to street dust, 90 and 80; spur gearing, steel pinion and fibre gear wheel, 88 and 80; spur gearing, leather pinion and cast iron gear wheel, 88 and 80; spur gearing, steel on steel, running in an oil bath, 92 and 90; bevel gearing, steel and steel, in an oil bath, 88 and 82; universal joint, 95; roller chain, lubricated and exposed to the air, 94 and 92.—*Iron Age.*



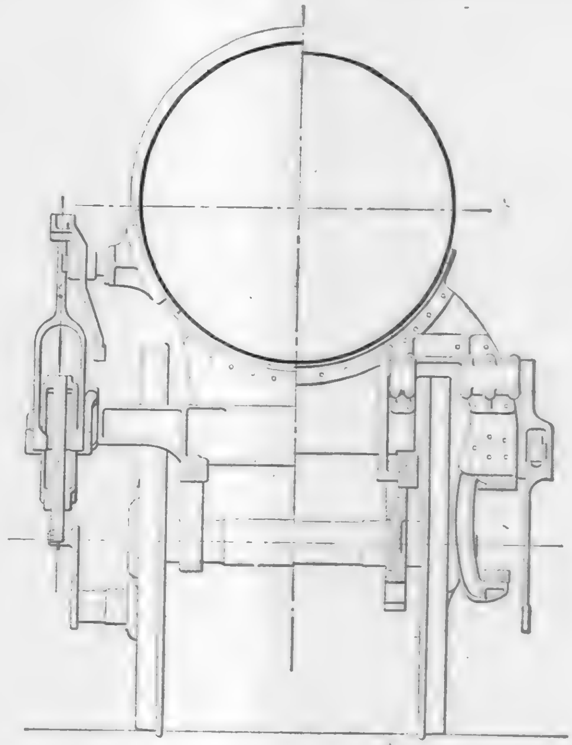
NEW YORK CENTRAL FREIGHT LOCOMOTIVE FITTED WITH WALSCHAERT VALVE GEAR.

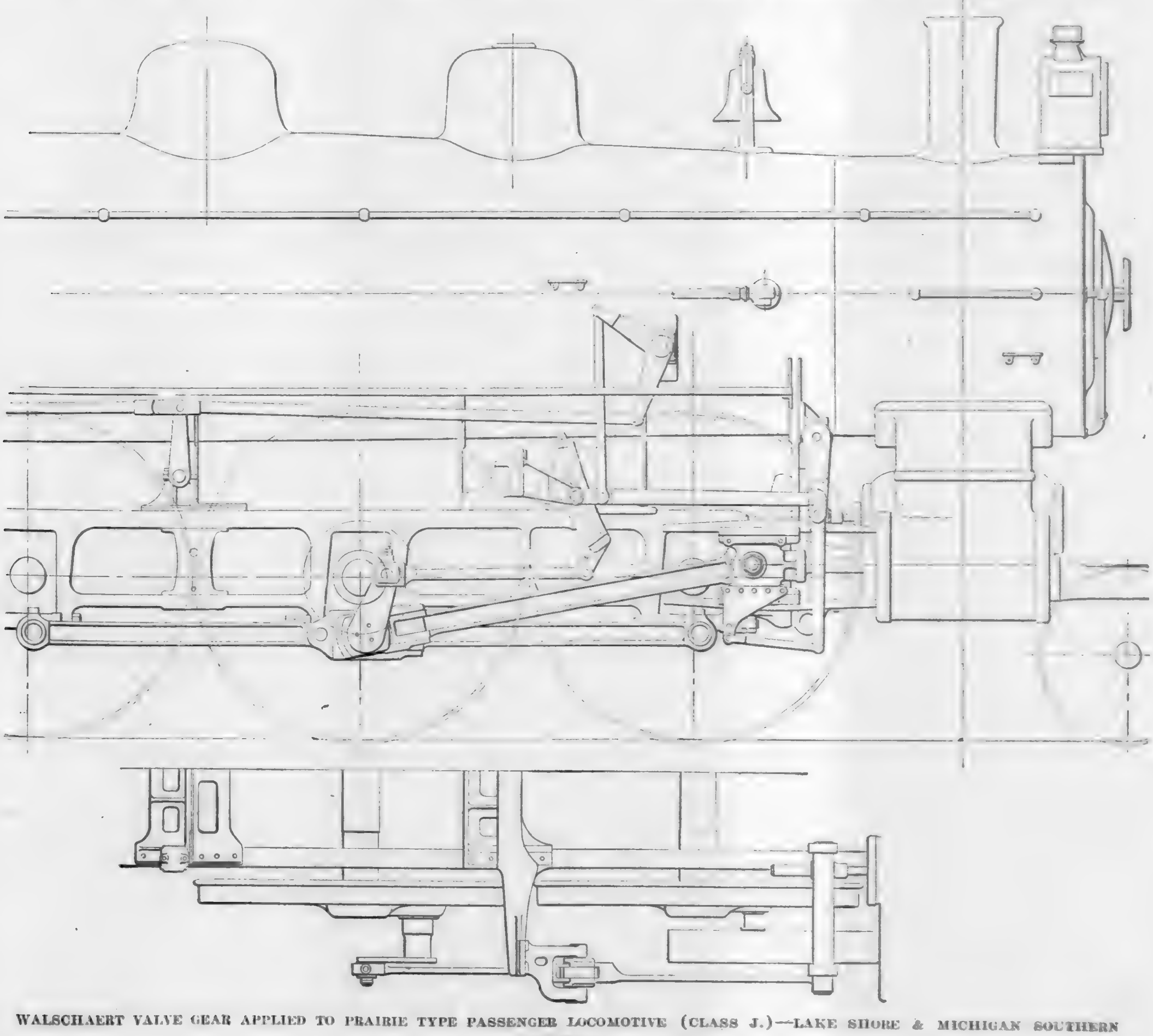
WALSCHAERT vs. STEPHENSON VALVE GEAR.

Walschaert valve gear is being seriously considered for use on Lake Shore locomotives. It has already been applied to a 2—8—0 locomotive (See AMERICAN ENGINEER, February, 1905, page 46), and service reports continue to be so favorable as to lead to the conclusion that it would be advantageous on passenger locomotives. This journal illustrated the Class J passenger locomotive in March, 1901, page 69, and the heavier Class K in November, 1904, page 413, and December, 1904, page 479. In the accompanying table the actual weights of the Stephenson gear are given for these three classes, the actual weights of the Walschaert for the 2—8—0 class, and estimated weights of the Walschaert gear for the two passenger classes. For Class K the saving in weight by using the latter gear is 1,745 lbs.

Since the application of the Walschaert gear to the Lake Shore locomotive, already referred to, it has been applied to a new consolidation locomotive, No. 2749, of the New York Central & Hudson River Railroad, a photograph of which is reproduced. This application is similar to that of the Lake Shore design.

In the line engraving the adaptation of the Class J, 2—6—2 passenger locomotive is illustrated. This locomotive was described in this journal in March, 1901, page 69, and the gear is to be applied in connection with an inside admission piston valve. This engine has a direct valve motion. In this con-





WALSCHAERT VALVE GEAR APPLIED TO PRAIRIE TYPE PASSENGER LOCOMOTIVE (CLASS J.)—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

COMPARATIVE WEIGHTS, STEPHENSON AND WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN LOCOMOTIVES.

	Class and Type					
	Class D, 2-8-0.		Class J, 2-6-2.		Class K, 2-6-2.	
	Stephenson. lbs.	Walschaert. lbs.	Stephenson. lbs.	Walschaert. lbs.	Stephenson. lbs.	Walschaert. lbs.
Crank pins, main	520	490	390	365	440	415
Crank pins, arms	..	100	..	80	..	90
Crosshead arms	..	60	..	50	..	50
Eccentric	600	..	740	..	740	..
Eccentric strap	800	..	880	..	1,120	..
Eccentric rods	200	220	200	175	280	200
Link	280	260	260	240	300	275
Link support	..	280	..	250	..	260
Link lifter	45	..	120	..	120	..
Reverse shaft & arms	260	400	350	375	385	390
Rockers	260	..	280	325	280	350
Rocker boxes	240	..	300	300	300	325
Transmission bar	300	140	270	160	300	170
Transmission bar hanger	80	72	120	65	120	75
Transmission bar bracket	..	..	..	..	200	..
Valve rod	80	70	130	100	100	100
Vibrating rod	..	220	..	180	..	180
Vibrating link	..	70	..	60	..	60
Total, lbs.	3,665	2,382	3,940	2,725	4,685	2,940
Saving in weight, lbs.		1,283		1,215		1,745

VALVE SETTING OF ENGINE 2749, WITH WALSCHAERT VALVE MOTION.

CUT-OFF POSITION. Forward Motion—	Pre-Admission.		Lead.		Port Opening.		Cut Off.		Release.		Closure.	
R. H. Side.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.
Full gear	0	0	3/16	3/16	2	2	27 13/16	26¾	30 1/16	30 1/16	1 15/16	1 15/16
Half stroke	7/16 S	7/16 S	3/16	3/16	9/16	9/16	16 5/16	16 1/16	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	8⅛	7 9/16	22	22	10	10
L. H. Side.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.
Full gear	0	0	3/16	3/16	2	2	27⅝	26 9/16	30 1/16	30 1/16	1 15/16	1 15/16
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	16	15 9/16	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	8	7 11/16	22	22	10	10
CUT-OFF POSITION. Backward Motion—	Pre-Admission.		Lead.		Port Opening.		Cut Off.		Release.		Closure.	
R. H. Side.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.
Full gear	0	0	3/16	3/16	2	2	27⅝	27¾	30	30	2	2
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	15¾	16⅞	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	6 13/16	8 1/16	22	22	10	10
L. H. Side.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.	Front.	Back.
Full gear	0	0	3/16	3/16	2	2	27⅝	27⅝	30	30	2	2
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	16⅛	17⅝	25 13/16	25 13/16	6 3/16	6 3/16
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	6 3/16	7⅝	21 15/16	21 15/16	10 1/16	10 1/16

Link radius	65 ins.
Link centre	50 ins.
Valve travel	6 ins.
Steam lap	1 in.
Steam lead forward	3-16 in.
Steam lead back	3-16 in.
Clearance	0 in.

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CONSOLIDATION LOCOMOTIVE—WALSCHAERT VALVE MOTION.

NEW YORK CENTRAL & HUDSON RIVER R. R.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bituminous coal
Tractive power	45,700 lbs.
Weight in working order	226,000 lbs.
Weight on drivers	201,000 lbs.
Weight of engine and tender in working order	369,200 lbs.
Wheel base, driving	17 ft. 6 ins.
Wheel base, total	26 ft. 5 ins.
Wheel base, engine and tender	60 ft. 6½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ heating surface	778
Heating surface ÷ grate area	65.8
Total weight ÷ tractive effort	4.9
CYLINDERS.	
Kind	Simple
Diameter and stroke	23 by 32 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	14-in. Piston
Greatest travel	6 ins.
Steam lap	⅞ ins.
Exhaust lap	Line and line
Lead in full gear	Line and line
WHEELS.	
Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 by 12 ins.
Engine truck wheels, diameter	33 ins.
BOILER.	
Style	Straight top
Working pressure	200 lbs.
Outside diameter of first ring	81⅝ ins.
Firebox, length and width	108 1-16 by 75¼ ins.
Firebox, plates, thickness	⅜ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	446 2-in.
Tubes, gauge and length	11, 15 ft. 0½ ins. long.
Heating surface, tubes	3,489.47 sq. ft.
Heating surface, arch tubes	27.41 sq. ft.
Heating surface, firebox	185.64 sq. ft.
Heating surface, total	3,702.52 sq. ft.
Grate area	56.25 sq. ft.
Exhaust pipe	Single.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 9¾ ins.
TENDER.	
Tank	Water bottom.
Frame	10-in. channels.
Weight, loaded	143,200 lbs.
Wheels, diameter	33 ins.
Water capacity	7,500 gals.
Coal capacity	12 tons.

ENORMOUS HEADS FOR WATER WHEELS.—The Abner Doble Company, of San Francisco, has recently installed three 7,500-h.p. tangential water wheels at the electric plant of the California Gas & Electric Corporation. They operate under a 1,250-ft. head of water, and run at 400 r.p.m. Two 75-h.p. Doble exciter wheels have been built for the Pike's Peak Hydro-Electric Railway of Colorado, to operate under a head of 2,100 ft., which is the greatest head of water in the United States.

TIRE STEEL.—The proper chemical composition of tire steel is an open question. Some roads specify 0.60 to 0.75 carbon and 0.20 to 0.30 silicon, and others specify lower contents of both of these. The Pennsylvania specification for passenger and freight is as follows:

Carbon	0.55 to 0.70
Silicon	0.10 to 0.20
Manganese	0.60 to 0.75
Sulphur, not to exceed	0.06
Phosphorous, not to exceed	0.05

—*(P. H. Dudley, before Int. Ry. Congress.)*

A LARGE SINGLE PHASE LOCOMOTIVE FOR HEAVY RAILROAD SERVICE.

Of the many interesting exhibits of railway appliances prepared for the inspection of the delegates to the International Railway Congress, probably the most novel, and certainly the most important in its bearing on the use of electricity as a motive power for heavy railroad service, was the Westinghouse-Baldwin single phase, alternating current locomotive, shown in operation May 16th on the Interworks Railway at East Pittsburgh. This locomotive was built by the Westinghouse Electric & Manufacturing Company in order to convince the railway managers of the possibilities and advantages of the use of single phase current for the heavy electric traction, and to demonstrate the ability of the company to supply the necessary apparatus. It was shown in operation first running light and then hauling a train of fifty new steel gondola cars, weighing, approximately, 1,200 tons.

This is the largest alternating current locomotive in the world, the largest to be operated by a single phase current, and it is equipped with six of the largest single phase motors ever built. It is the first alternating current locomotive for use in America, and is designed for the highest trolley voltage ever used in this country. This locomotive is also the largest ever operated by means of overhead trolleys, is the first on which forced ventilation is used on the motors, and is unique in other respects.

The weight of the locomotive complete is 135 tons. It is built in two halves, each having one six-wheel truck with rigid wheel base. These are coupled together, and are intended to operate normally as a single unit, but each half may be operated separately if desired. The locomotive is approximately 45 ft. long over all, and 9 ft. 8 ins. wide. The total height above the rail with trolleys lowered is 17 ft. The wheels are 60 ins. in diameter, and are mounted on 8-in. axles, with 6 ft. 4 ins. between centers. The side frames of the truck are of cast steel and are spring supported in the usual manner, the weight on the two inside axles of each truck being equalized. The cabs are built of sheet steel with angle iron supports, and the entire cab as a whole is removable from the truck. Each axle carries a 225 h.p. single phase series motor of the single reduction geared type, making a total of six motors for the locomotive. One side of each motor is supported directly on the axle and the other is suspended by spiral springs from the locomotive body. The motors are of the same general construction as the standard Westinghouse alternating current railway motors of smaller size, which have been previously described in these columns. They are so arranged that forced ventilation may be used and increased output thus secured.

The locomotive is designed for a current of 25 cycles and a trolley voltage of 6,000, and one of the most striking points of the exhibition to those who have been accustomed to the enormous currents required in heavy direct traction work was the sight of so large a locomotive accelerating a 1,200-ton train over a third of a mile in length and receiving its entire power supply from a single No. 000 trolley wire. The 6,000-volt current is collected from the trolley wire by a pneumatically operated pantagraph trolley on each half of the locomotive, and is carried through a suitable oil switch and circuit breaker to an auto-transformer in each cab. These transformers reduce the voltage to 325 for use at the motors. The trolleys may be raised or lowered from the cab by a suitable air valve.

The three motors on each half of the locomotive are connected permanently in parallel and are controlled by means of an induction regulator, which, under the direction of the operator, varies the voltage at the motors from about 140 to 325. The induction regulators are driven by small series motors of the same general type as the main motors. Both regulators are controlled by the multiple unit system from a master switch at either end. They may be stopped at any desired point in their travel, and thus the locomotive may be run at any speed with the same facility and economy as a steam locomotive. Forced ventilation is used with the auto-transformers and induction regulators as well as with the motors, the necessary air being supplied by motor-driven blowers. Motor-driven air compressors are also used.

The locomotive is designed for slow speed freight service, this type having been chosen because the design of series alternating current motors for very slow speed service presents many more problems and is much more difficult than the design of equal capacities for the ordinary conditions. This problem having been solved, the production of similar locomotives for passenger service becomes a relatively simple matter. With the motors working at nominal full load output the locomotive will develop a draw bar pull of 50,000 lbs. at a speed of approximately 10 miles per hour. On several occasions, however, when hauling the 50-car train referred to above, steady draw bar pulls of from 60,000 to 65,000 lbs. have been recorded on the dynamometer car, and momentary efforts as high as 100,000 lbs. have been obtained with no sign of slipping of the wheels. With lighter loads the locomotive may be run at higher speeds up to a maximum of about 30 miles per hour.

The successful completion of so large and powerful an alternating current locomotive without the usual series of developments through gradually increasing sizes, which is ordinarily required when so great a problem is undertaken, marks a distinct advance in the production of electrical apparatus for heavy traction work.

WESTINGHOUSE SINGLE PHASE LOCOMOTIVE AND FIFTY-CAR TRAIN.

INDEPENDENT MOTOR COACH.—The Glasgow & Southwestern Railway, of which Mr. James Manson is locomotive superintendent, has built an independent steam motor coach, with the locomotive and coach on a single frame, which is 60 ft. 8 ins. long over end sills. The car seat 50 passengers. The length of the body itself is 41 ft. The diameter of the wheels is 42 ins. The locomotive has 9 x 15-in. cylinders and a horizontal boiler, with 8 sq. ft. of grate surface and 440 sq. ft. of heating surface. The boiler has 138 1⅝-in. tubes. This unit is for use in local traffic.

COMPARATIVE WEIGHTS, STEPHENSON AND WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN LOCOMOTIVES.

	Class D, 2-8-0. Stephenson. lbs.	Class D, 2-8-0. Walschaert. lbs.	Class J, 2-6-2. Stephenson. lbs.	Class J, 2-6-2. Walschaert. lbs.	Class K, 2-6-2. Stephenson. lbs.	Class K, 2-6-2. Walschaert. lbs.
Crank pins, main	520	490	390	365	440	415
Crank pins, arms	..	100	..	80	..	90
Crosshead arms	..	60	..	50	..	50
Eccentric	600	..	740	..	740	..
Eccentric strap	800	..	880	..	1,120	..
Eccentric rods	200	220	200	175	280	200
Link	280	260	260	240	300	275
Link support	..	280	..	250	..	260
Link lifter	45	..	120	..	120	..
Reverse shaft & arms	260	400	350	375	385	390
Rockers	260	..	280	325	280	350
Rocker boxes	240	..	300	300	300	325
Transmission bar	300	140	270	160	300	170
Transmission bar hanger	80	72	120	65	120	75
Transmission bar bracket	..	..	..	..	200	..
Valve rod	80	70	130	100	100	100
Vibrating rod	..	220	..	180	..	180
Vibrating link	..	70	..	60	..	60
Total, lbs.	3,665	2,382	3,940	2,725	4,685	2,940
Saving in weight, lbs.		1,283		1,215		1,745

Weight of engine and tender in working order .... 369,200 lbs.
Wheel base, driving .... 17 ft. 6 ins.
Wheel base, total .... 26 ft. 5 ins.
Wheel base, engine and tender .... 60 ft. 6½ ins.

RATIOS.

Tractive weight ÷ tractive effort 4.4
Tractive effort x diam. drivers ÷ heating surface 778
Heating surface ÷ grate area 65.8
Total weight ÷ tractive effort 4.9

CYLINDERS.

Kind .... Simple
Diameter and stroke .... 23 by 32 ins.
Piston rod, diameter .... 4 ins.

VALVES.

Kind .... 14-in. Piston
Greatest travel .... 6 ins.
Steam lap .... ⅞ ins.
Exhaust lap .... Line and line
Lead in full gear .... Line and line

WHEELS.

Driving, diameter over tires .... 63 ins.
Driving, thickness of tires .... 3½ ins.
Driving journals, main, diameter and length .... 10 by 12 ins.
Engine truck wheels, diameter .... 33 ins.

BOILER.

Style .... Straight top
Working pressure .... 200 lbs.
Outside diameter of first ring .... 81⅝ ins.
Firebox, length and width .... 108 1-16 by 75¼ ins.
Firebox, plates, thickness .... ⅜ and 9-16 in.
Firebox, water space .... 4½ ins.
Tubes, number and outside diameter .... 446 2-in.
Tubes, gauge and length .... 11, 15 ft. 0½ ins. long
Heating surface, tubes .... 3,489.47 sq. ft.

VALVE SETTING OF ENGINE 2749, WITH WALSCHAERT VALVE MOTION.

Cut-Off Position. Forward Motion—

R. H. Side.	Pre-Admission. Front.	Pre-Admission. Back.	Lead. Front.	Lead. Back.	Port Opening. Front.	Port Opening. Back.	Cut Off. Front.	Cut Off. Back.	Release. Front.	Release. Back.	Closure. Front.	Closure. Back.
Full gear	0	0	3/16	3/16	2	2	27 13/16	26¾	30 1/16	30 1/16	1 15/16	1 15/16
Half stroke	7/16 S	7/16 S	3/16	3/16	9/16	9/16	16 5/16	16 1/16	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	8⅛	7 9/16	22	22	10	10
L. H. Side.	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**
Full gear	0	0	3/16	3/16	2	2	27⅜	26 9/16	30 1/16	30 1/16	1 15/16	1 15/16
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	16	15 9/16	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	8	7 11/16	22	22	10	10

Cut-Off Position. Backward Motion—

R. H. Side.	Pre-Admission. Front.	Pre-Admission. Back.	Lead. Front.	Lead. Back.	Port Opening. Front.	Port Opening. Back.	Cut Off. Front.	Cut Off. Back.	Release. Front.	Release. Back.	Closure. Front.	Closure. Back.
Full gear	0	0	3/16	3/16	2	2	27⅜	27¾	30	30	2	2
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	15¾	16⅞	25⅞	25⅞	6⅛	6⅛
Quarter stroke	11/16	11/16	3/16	3/16	¼	¼	6 13/16	8 1/16	22	22	10	10
L. H. Side.	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**	**Front.**	**Back.**
Full gear	0	0	3/16	3/16	2	2	27⅝	27⅜	30	30	2	2
Half stroke	7/16	7/16	3/16	3/16	9/16	9/16	16⅛	17⅜	25 13/16	25 13/16	6 3/16	6 3/16
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Link radius .... 65 ins.
Link centre .... 50 ins.
Valve travel .... 6 ins.
Steam lap .... 1 in.
Steam lead forward .... 3-16 in.
Steam lead back .... 3-16 in.
Clearance .... 0 in.

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GENERAL DATA.

Gauge .... 4 ft. 8½ ins.
Service .... Freight
Fuel .... Bituminous coal
Tractive power .... 45,700 lbs.
Weight in working order .... 226,000 lbs.
Weight on drivers .... 201,000 lbs.

Heating surface, arch tubes .... 27.41 sq. ft.
Heating surface, firebox .... 185.64 sq. ft.
Heating surface, total .... 3,702.52 sq. ft.
Grate area .... 56.25 sq. ft.
Exhaust pipe .... Single
Smokestack, diameter .... 20 ins.
Smokestack, height above rail .... 14 ft. 9¾ ins.

TENDER.

Tank .... Water bottom
Frame .... 10-in. channels
Weight, loaded .... 143,200 lbs.
Wheels, diameter .... 33 ins.
Water capacity .... 7,500 gals.
Coal capacity .... 12 tons

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Phosphorous, not to exceed 0.05

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This is the largest alternating current locomotive in the world, the largest to be operated by a single phase current, and it is equipped with six of the largest single phase motors ever built. It is the first alternating current locomotive for use in America, and is designed for the highest trolley voltage ever used in this country. This locomotive is also the largest ever operated by means of overhead trolleys, is the first on which forced ventilation is used on the motors, and is unique in other respects.

power supply from a single No. 000 trolley wire. The 6,000 volt current is collected from the trolley wire by a pneumatically operated pantagraph trolley on each half of the locomotive, and is carried through a suitable oil switch and circuit breaker to an auto-transformer in each cab. These transformers reduce the voltage to 325 for use at the motors. The trolleys may be raised or lowered from the cab by a suitable air valve.

The three motors on each half of the locomotive are connected permanently in parallel and are controlled by means of an induction regulator, which, under the direction of the operator, varies the voltage at the motors from about 140 to 325. The induction regulators are driven by small series motors of the same general type as the main motors. Both regulators are controlled by the multiple unit system from a master switch at either end. They may be stopped at any desired point in their travel, and thus the locomotive may be run at any speed with the same facility and economy as a steam locomotive. Forced ventilation is used with the auto-transformers and induction regulators as well as with the motors, the necessary air being supplied by motor-driven blowers. Motor-driven air compressors are also used.

The locomotive is designed for slow speed freight service, this type having been chosen because the design of series alternating current motors for very slow speed service presents many more problems and is much more difficult than the design of equal capacities for the ordinary conditions. This

WESTINGHOUSE SINGLE PHASE LOCOMOTIVE AND FIFTY-CAR TRAIN.

problem having been solved, the production of similar locomotives for passenger service becomes a relatively simple matter. With the motors working at nominal full load output the locomotive will develop a draw bar pull of 50,000 lbs. at a speed of approximately 10 miles per hour. On several occasions, however, when hauling the 50-car train referred to above, steady draw bar pulls of from 60,000 to 65,000 lbs. have been recorded on the dynamometer car, and momentary efforts as high as 100,000 lbs. have been obtained with no sign of slipping of the wheels. With lighter loads the locomotive may be run at higher speeds up to a maximum of about 30 miles per hour.

The weight of the locomotive complete is 135 tons. It is built in two halves, each having one six-wheel truck with rigid wheel base. These are coupled together, and are intended to operate normally as a single unit, but each half may be operated separately if desired. The locomotive is approximately 45 ft. long over all, and 9 ft. 8 ins. wide. The total height above the rail with trolleys lowered is 17 ft. The wheels are 60 ins. in diameter, and are mounted on 8-in. axles, with 6 ft. 4 ins. between centers. The side frames of the truck are of cast steel and are spring supported in the usual manner, the weight on the two inside axles of each truck being equalized. The cabs are built of sheet steel with angle iron supports, and the entire cab as a whole is removable from the truck. Each axle carries a 225 h.p. single phase series motor of the single reduction geared type, making a total of six motors for the locomotive. One side of each motor is supported directly on the axle and the other is suspended by spiral springs from the locomotive body. The motors are of the same general construction as the standard Westinghouse alternating current railway motors of smaller size, which have been previously described in these columns. They are so arranged that forced ventilation may be used and increased output thus secured.

The locomotive is designed for a current of 25 cycles and a trolley voltage of 6,000, and one of the most striking points of the exhibition to those who have been accustomed to the enormous currents required in heavy direct traction work was the sight of so large a locomotive accelerating a 1,200-ton train over a third of a mile in length and receiving its entire

The successful completion of so large and powerful an alternating current locomotive without the usual series of developments through gradually increasing sizes, which is ordinarily required when so great a problem is undertaken, marks a distinct advance in the production of electrical apparatus for heavy traction work.

INDEPENDENT MOTOR COACH.—The Glasgow & Southwestern Railway, of which Mr. James Manson is locomotive superintendent, has built an independent steam motor coach, with the locomotive and coach on a single frame, which is 60 ft. 8 ins. long over end sills. The car seat 50 passengers. The length of the body itself is 41 ft. The diameter of the wheels is 42 ins. The locomotive has 9 x 15-in. cylinders and a horizontal boiler, with 8 sq. ft. of grate surface and 440 sq. ft. of heating surface. The boiler has 138 1⅝-in. tubes. This unit is for use in local traffic.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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We cordially invite our many friends attending the conventions at Manhattan Beach in June to make use of our offices. Telegrams and mail addressed in our care will receive careful attention.

LOCOMOTIVE REPAIR ACCOUNTS.

The system of locomotive repair accounts introduced by Mr. H. H. Vaughan, superintendent of motive power of the Canadian Pacific, is described by him on another page of this issue. This article should be taken under serious consideration by every motive power and operating official because of the importance of motive power records in the operation of railroads. It is believed that no more important suggestion than this has ever been made with respect to the records of the cost of locomotive maintenance.

PERFORMANCE OF BALTIMORE & OHIO MALLET COMPOUND LOCOMOTIVE.

Those who have predicted all kinds of troubles and failures with the large Mallet articulated compound locomotive, built by the American Locomotive Company for the Baltimore & Ohio Railroad, and illustrated in this journal in June of last year, should carefully note the statements by Mr. J. E. Muhlfeld, superintendent of motive power of that road, which appear elsewhere in this issue. The locomotive has been entirely successful, and Mr. Muhlfeld presents interesting figures concerning 60-mile freight runs and 15-mile pusher runs. His statements are of great importance in view of the advantages offered by the Mallet type of construction for large locomotives. This locomotive seems to be just the thing for heavy mountain service, and strong arguments for using the same type of construction for heavy road locomotives may be based upon this experience. Especially noteworthy is the fact that the work described was performed with the service of but one fireman.

ELECTRICITY ON STEAM RAILROADS.

The paper on "Electricity on Steam Railroads," presented before the Western Railway Club by Mr. Clement F. Street is the most complete and valuable contribution on this subject which we have seen. The paper is such that it cannot properly be presented in abstract, and those interested should obtain complete copies of it. Mr. Street states that the indications are that within the next few years a large proportion of the heavy suburban service, the demands of which are even now beyond the capacity of steam locomotives, will be handled by electric equipment. The next service in which it will be introduced will be for pushers on heavy grades, and from this and suburban service extensions will be made to entire divisions and trunk lines, although the extensions to the trunk lines will not be made in the near future.

The benefits to be gained from the electrical operation of suburban service are as follows: Increase in gross receipts, better application of power to trains, increased capacity of terminals, reduction in operating expenses, reduction in terminal costs, reduction in cost of maintenance of equipment, increased reliability of service and reduction in coal consumption. Instances are cited where the gross receipts of suburban roads have increased from 46 to 68 per cent. after the introduction of electrical operation. A system of traction having power units attached to the trucks of the cars is desirable in suburban service for the following reasons: A high rate of acceleration can be obtained; a change in the weight of the train does not cause a corresponding change in the rate of acceleration; the rate of acceleration can be changed to suit different conditions; switch engines are not required, and the draw bar strains are distributed. The capacity of terminals is increased, since only one or two switching operations are required with electrically operated trains, while from 5 to 7 operations are required with steam locomotives, and considerable time is also saved due to the quicker acceleration of the electric trains.

With electric cars the terminal costs are reduced by about 60 per cent., and the investment in buildings and equipment by 80 to 90 per cent. Roundhouses, cinder pits, boiler washing, cleaning of flues and grates, packing of cellars, firing up of engines, turn-table expenses and coal trestles are eliminated. Assuming that six car trains can be operated with one locomotive or three motor cars, the terminal cost of the electric equipment per day is about 65 cents, as compared to $1.53 for the locomotive. Statistics which are presented indicate that the cost of maintenance of equipment is much less for electric than for steam roads.

Mr. Street considers at length the different systems of electric traction and the relative advantages of the third rail and the trolley. He advocates the use of the single-phase alternating current system and an overhead conductor.

INTERNATIONAL RAILWAY CONGRESS.

An idea of the scope of the recent meeting of the International Railway Congress in Washington is conveyed by the fact that forty-six different countries were represented by delegates, the number of railroads being 404, the total number of delegates 568, of which 286 were foreign and 282 American. The railways represented aggregated 310,940 miles. While the delegates met for the consideration of a large number of subjects concerning railway transportation, the convention itself was by no means the most important feature of this assemblage of those who are conducting the most important development of the time. Aside from the foreign delegates, never before has there been such a gathering of American railway officials, including owners, financiers, managing, engineering and motive power men. The Congress may be considered an epoch-making event, making for a better understanding not only among railway men of different countries, but among those of this country, and the lesson of the Congress is the importance of occasionally getting together

all the officials of all the departments for a study of their common problem.

The value of the official discussions would have been much greater if those other than delegates were permitted to know exactly what was said in the meetings. The reports of the discussions, after the censors had finished with them, were robbed of much of their value and it is to be hoped that at some future time the star chamber character of the discussions may give place to a more modern and enlightened plan, as there can be no satisfactory reason at this day and date for discussing technical railroad subjects behind closed doors.

As is usual on such occasions, intercourse during leisure moments on the excursions and at the banquets, was an exceedingly valuable feature of the gathering. No one could attend, in the proper spirit, without deriving hundreds of inspirations from the men he met who are earnestly devoting themselves to transportation.

Comments from various prominent officials were heard. A well known general manager stated that "This is the best convention of any kind I ever attended." Another said: "Great good will come from this assemblage of serious-minded, able men of the highest responsibilities, and noblest purposes."

Undoubtedly the strongest feature of the convention was the remarkable exhibit of the American Railway Appliance Exposition with over 300 members and exhibitors. These exhibits were representative of American railway appliances in an effort to show our practice to foreigners, and its scope was so great and the individual exhibits so good as to warrant the statement that American railway officials could derive more from it than could the foreigners. Among the mechanical appliances there were few that were new to those who are carefully watching progress. Throughout the exhibition, however, were many new applications which have not been seen at any previous exhibition. The value of this feature of the Congress centered in the fact that the owners, presidents, general managers and other high officials, mingled with their department subordinates in making a careful study of equipment and appliances.

At a casual gathering of nine or ten railroad presidents one evening the decision was reached that they should send for their mechanical and engineering officials. One road sent a delegation of 26 men; from other roads representatives visited the exhibits in groups of five or six and in many cases these men were required to render reports of what they saw. One of the exhibiting companies had a force of 40 men at the Congress. This company had appropriated $35,000 for its expenses, including the exhibit. Such men as Mr. Stuyvesant Fish expressed the opinion that the exhibition was the most important feature of the Congress. To one who carefully studied the exhibits and noted the care with which they were examined by the higher officials it must have been evident that this exhibition has performed a mission in raising the dignity of the motive power problem by showing the higher officials how great the problem is.

It would be useless to attempt a description in detail, but it is sufficient to say that a week was too short a time for a complete study of the exhibition. The attendance averaged over 2,000 per day. The value of the results cannot possibly be estimated. The exhibition was of the most definite character, classified along straight lines, leading in the direction of improvement in developing track, operation and shop practice, making for economy, celerity of work and service and certainty as well as safety of operation. If the railroads and their very high officials have learned the lessons of this Congress they have obtained a better insight into the problems of operation than was ever possible to obtain before.

For this remarkable exhibition great credit is due the American manufacturers of railway equipment and appliances. No previous exhibition has ever approached the importance of this one and another like it is not to be expected for some time to come.

Taken as a whole, the gathering at Washington was a complete and unqualified success from the American as well as the foreign standpoint.

NEGLECTED APPRENTICESHIP.

Proper provision for the men of the future in shops, on locomotives, on the road, at the telegraph key, and everywhere else on railroads, is being neglected to an extent which is absurd, ridiculous and positively unsafe. A day of reckoning is to come, and our brightest, ablest and strongest railroad officials are to be judged and found wanting, unless they awake to the situation and meet the need promptly, thoroughly and permanently.

There are tons of literature on the subject of apprenticeship, yet so little is actually done as to justify the statement that, while the principles are understood, apprenticeship is neglected by American railroads.

Many trades are represented in a modern railroad shop, often numbering twelve or more. It is the exception rather than the rule to find half of these trades provided with apprentices. As important a trade as boiler-making is usually entirely barren of apprentices.

In the editorial office of this journal damaging evidence may be shown to incriminate railroad officers in the use of apprenticeship on important machines to keep down the cost of locomotive repairs. Complaint is made that the labor unions restrict the number of apprentices. This is true—but the use made of the boys and the lack of training in the shops warrants the statement that those we have are abused. Notable exceptions only prove the rule.

These criticisms are not confined to apprentices. During the past year firemen have been put to work with woefully insufficient training. What can be expected of a man firing a heavy freight locomotive after only one week of instruction, and that confined to what is given him by the fireman he works under on the locomotive. Even the electric street railroads do better than this with their motormen.

These facts are known to the officials. What is the reason for the distressing neglect of recruiting methods and apprenticeship in general?

The reason is simple. It is no one's special business to look after the men of the future, and the higher officials are too busy with the present to think of the future. That is all, and when the facts which are now known become appreciated a wave of improvement will sweep the country from end to end. This wave cannot start too soon. It is already about twenty years behind its schedule.

Here are some pointed questions for presidents, general managers and superintendents of motive power:

What has become of the *esprit de corps* of railroad organizations of a generation ago?

What are the railroads doing to meet the new conditions of management of men arising because of the increase in size of railroads and their aggregation into systems?

What has become of the apprenticeship under which you grew up?

What policy are you pursuing in order to direct the natural leadership talent among your men into useful and helpful channels?

Why do you ever go outside of your own staff of subordinate officials and men to fill important positions?

From the standpoint of organization, what are you doing to render your successor's position easier than yours has been?

As to organization, what can railroads learn from a large army?

Why has special apprenticeship of college men proved a failure in the matter of providing subordinate and higher officials?

This may not be a popular subject, but it must not be laid aside for that reason. It is time that a warning should be sounded in this most important tendency toward trouble in the future. It is not sufficient to provide evening schools for one or two subjects. Evening schools may form the basis for building up for the future, but they cannot present a solution of the problem now facing the railroads. A new apprenticeship with a new educational system is needed.

WALSCHAERT VALVE GEAR.

American locomotive development during the past twenty-five years has not brought the improvements of valve gear mechanism up to correspond with other improvements of our powerful locomotives. American railroad officials and locomotive designers have continued to apply the old Stephenson link motion practically to the exclusion of all other valve motions. While this gear has proved successful on locomotives of moderate size and has given good satisfaction, it has been impossible, on account of the limitations of gauge of track and the enlargement of the other parts of the locomotive, to increase valve gear proportions in proper ratio. The size of eccentrics is not proportionately larger upon the largest engines now built than upon the small engines of a quarter of a century ago. Consequently the wear, breakage and renewals of these parts is greater than it should be. If, however, the size of eccentrics could be increased proportionately to the size of the locomotive, they would give trouble because of high surface velocity.

European locomotive builders during this period have been in advance of us and have for a number of years used the Walschaert valve gear. Probably 90 per cent. of the main line passenger and freight locomotives annually built upon the continent are equipped with it. English locomotive men have, like ourselves, been slow to change from the Stephenson link motion, but in this they are more excusable because the small size of their engines still permits of proper proportions for the work performed.

Realizing that the limitation of the Stephenson link motion has been reached, the American Locomotive Company last year adapted the Walschaert valve gear to the Mallet compound locomotive built for the Baltimore & Ohio Railroad and exhibited at the St. Louis Exposition. This engine, which has been illustrated in this journal in June, 1904, page 237, is a 4-cylinder articulated compound, the heaviest and most powerful ever constructed. While this type of valve gear has been previously used in this country upon small locomotives and small motor cars this was its first application to a heavy American road locomotive. As recorded in this journal it has since been applied to heavy consolidation locomotives for the Lake Shore & Michigan Southern and the New York Central & Hudson River railroads. The American Locomotive Company is recommending the adoption of Walschaert gear to all types of heavy locomotives, both for the highest speed passenger service and the heaviest and slowest freight service.

This gear is specially well adapted to modern high efficiency engines, and on account of the construction which places all the heavy wearing surfaces outside of the wheels, where they are readily accessible for inspection and lubrication, the gear has met with unexpected favor from all classes of railway officials as well as the men who run the engines.

Operation.—The Stephenson gear increases the lead as the cut-off is shortened. The Walschaert gives a constant lead at all cut-offs from full to mid-gear. The constant lead is an advantage, as in the case of the link motion it is a difficult matter to obtain sufficient lead with large cylinders in the longer cut-offs and at the same time keep down the lead and consequent pre-admission and excess of compression in the shorter cut-offs where most of the high speed work is performed. The advantages of constant lead on large cylinder engines is manifest because of the possibility of giving an amount of lead in long cut-offs to properly cushion the reciprocating parts and at the same time reduce the pre-admission and compression of short cut-offs, thus making a freer working and easier running engine, saving steam and reducing the pounding of bearings.

Construction.—The valve is operated by means of a slotted link of suitable radius, pivoted at its center and reciprocated by a connecting rod attached to its lower end, the connecting rod deriving its motion from a return or eccentric crank secured to the main crank pin. The valve stem is connected to the link by a pivoted transmission bar, which is raised and lowered in the link by means of the reverse lever, the varying positions of the block in the link controlling the cut-off from full gear ahead to mid-gear and thence to full gear in backward motion.

If the valve were actuated by this combination alone there would be no lap or lead, consequently it was necessary to supply a secondary motion to give the necessary lap and lead. This is done by means of a pendulum lever, the upper end of which is attached to the valve stem and the lower connected to the cross head by a suitable link. The transmission bar is pivoted to this lever at its upper end, the ratio between the pivot point being that of half the travel of the cross head to the lap of the valve plus the lead. A motion is thus obtained which causes the valve to perform its proper function in an arrangement which brings the connections into practically the same vertical plane, thus centralizing the strains in approximately straight lines. Where the distribution valves are located in the cylinder saddle they are operated by means of an ordinary rocker shaft. All connections have case-hardened pins and lubricated bushings, except that upon the return crank pin, which is fitted with an adjustable bronze bearing. It will readily be seen that this motion possesses superior advantages, which may be summed up as follows:

Advantages.—Reduced weight of moving parts of the valve gear, reduced first cost when compared with bronze eccentric straps, reduced cost of maintenance, accessibility of all parts for inspection, accessibility of all parts for lubrication, elimination of frequent renewals and repairs, a construction permitting better and stronger bracing of frames, construction permitting the use of longer driving box bearings, easier access to main driving box cellars. This motion does not "get out of square" like the Stephenson motion, but the valves retain their original setting.

The Walschaert gear is not new, but is introduced into American parctice to meet the conditions of heavy road service because of conditions which are new. Egide Walschaert was born near Brussels in 1820. While in the service of the Belgium State Railways he patented his valve gear in 1844. This valve gear eventually became the valve gear of Europe. He died in 1901 near Brussels at the age of 81 years. We may pay tribute to his genius in having developed over 60 years ago something which we find we greatly need to-day.

CAST IRON WHEELS IN PASSENGER AND FREIGHT SERVICE.

Chicago, Milwaukee & St. Paul Railway.

The Chicago, Milwaukee & St. Paul Railway is a notable example of a road making general use of cast iron wheels in passenger as well as freight service. From the wheel records which have been carefully kept since 1885, interesting information is obtained. In this journal for June, 1889, page 191, the record up to that date was published. Mr. A. E. Manchester, superintendent of motive power, has kindly supplied the figures bringing the record down to date.

Attention should be directed to the fact that the average mileage is obtained by dividing the total car mileage during any year by the number of wheels taken out. If 10,000 wheels are in service and 1,000 are removed each year, the average length of service would be 10 years, and the average mileage would be 10 times the yearly mileage of the cars. This does not give accurate figures for any particular year, but it does give a correct method of comparison when a number of years are covered, and the statement shows the average mileage of all wheels taken out for all causes.

The shorter life of freight wheels shown for the years 1903 and 1904 is due to two causes. During the last five years this company has added to its equipment a number of 40 and 50-ton cars, which are special cars, used in ballast, ore and coal service. These cars make more mileage than other cars in general service, and the weight of the cars and their greater mileage account for the reduced mileage of the wheels. Furthermore, in all of the heavier equipment the inspection of

wheels is more rigid, and they are withdrawn when in better condition than was the practice with the older equipment. This record, therefore, shows the results of heavier cars, and is exceedingly important in the experience with cast iron wheels on this road. It is significant that the records for the last two years are below those of the previous 13 years.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY, MOTIVE POWER DEPARTMENT.

COMPARATIVE STATEMENT, SERVICE OF FREIGHT CAR WHEELS, YEARS 1885–1904.

Year.	Number of freight wheels made or bought for repairs	Freight car mileage.	Number of freight cars.	Number of freight wheels in service.	Average mileage.	Average life of wheels. Days.	Months.	Years.
1885....	22,395	215,459,302	19,402	155,216	76,968	6	11	15
1886....	19,459	236,140,449	21,385	171,080	97,080	8	9	15
1887...	24,721	250,774,965	21,678	173,424	81,152	7	0	1
1888...	24,162	261,400,022	22,544	180,352	86,544	7	5	17
1889...	26,015	250,990,286	22,776	182,208	77,184	7	0	1
1890...	15,823	263,983,845	23,864	190,912	133,468	12	0	24
1891...	12,810	305,482,341	25,674	205,392	190,776	16	0	12
1892...	17,340	334,943,674	26,308	210,372	154,528	12	1	18
1893...	17,332	312,503,242	27,963	223,612	144,240	12	10	24
1894...	11,647	276,300,355	27,800	222,400	189,784	19	1	4
1895...	14,219	289,316,350	27,687	221,408	162,776	15	6	26
1896...	19,569	315,810,431	27,645	221,072	129,104	11	3	22
1897...	14,634	292,285,995	27,517	220,048	159,784	15	0	13
1898...	19,420	344,752,791	30,120	240,876	142,020	12	4	25
1899...	19,304	376,759,163	34,103	272,748	156,137	14	2	23
1900...	22,380	400,818,214	36,324	290,516	143,288	12	11	23
1901...	26,667	411,919,765	38,015	304,048	123,574	11	4	25
1902...	23,816	442,864,874	39,419	315,284	148,762	13	2	26
1903...	33,530	452,644,207	40,678	325,368	107,998	9	8	13
1904...	37,212	438,606,750	41,827	334,560	94,296	8	11	27

In 1887 about one-half of the wheels used were made in contracting chills.
In 1902, 5,000 common chill wheels were bought.
In 1903, 12,500 common chill wheels were bought.
In 1904, 7,500 common chill wheels were bought.
All other wheels used subsequent to 1887 were made in contracting chills.

STATEMENT SHOWING C. M. & ST. PAUL RY. CAST WHEELS IN PASSENGER SERVICE.

All Wheels Scrapped Except for Sliding.

Year.	Passenger. No. of wheels.	Average mileage.	Bag. mail and express. No. of wheels.	Average mileage.	Parlor and sleeper. No. of wheels.	Average mileage.	Total. No. of wheels.	Average mileage.
1899...	713	96,741	792	105,672	102	92,827	1,607	100,983
1900...	821	104,740	916	108,956	171	113,316	1,908	107,533
1901...	952	91,533	929	97,563	114	96,115	1,995	94,603
1902...	919	88,674	887	93,530	111	83,097	1,917	90,598
1903...	1,163	88,463	1,215	98,108	141	83,191	2,519	92,820
1904...	1,708	96,770	1,585	100,031	137	100,510	3,430	98,426
			All Wheels Scrapped on Account of Sliding.					
1899...	719	44,114	338	52,843	228	29,860	1,285	43,663
1900...	667	39,146	302	48,194	184	41,521	1,153	41,982
1901...	678	41,173	298	48,317	130	40,257	1,106	42,989
1902...	843	40,482	319	48,721	222	34,471	1,384	41,417
1903...	666	45,838	326	51,433	170	37,541	1,162	46,194
1904...	818	42,686	349	42,362	138	33,930	1,305	41,673
			All Wheels Scrapped.					
1899...	1,432	70,417	1,130	89,870	330	49,020	2,892	75,577
1900...	1,488	75,404	1,218	93,891	355	76,104	3,061	82,841
1901...	1,630	70,586	1,227	85,602	244	66,353	3,101	76,194
1902...	1,762	65,617	1,206	81,677	333	50,680	3,301	69,978
1903...	1,829	72,942	1,541	88,234	311	58,238	3,681	78,101
1904...	2,526	79,755	1,934	89,625	275	67,099	4,735	82,785

AXLE INSPECTION IN A LATHE.—At the Montreal shops of the Canadian Pacific all driving wheel tires are turned in one 90-in. lathe. After the wheels are set in the machine and the turning begins, a helper paints the axle journals with white lead and oil. The jar of the lathe renders it possible to discover cracks which are not revealed by any other method of inspection.

USE OLD BOILER STEEL.—The blacksmith shop was short of billets. Sets of guides were required for wreck repairs of two engines which were greatly needed on the road. The foreman of the blacksmith shop used old boiler steel. It was piled, heated in an oil furnace, welded and hammered into guides. This mild steel is now giving excellent service in those guides.

ANGUS LOCOMOTIVE SHOPS.

CANADIAN PACIFIC RAILWAY.

VII.

(*For Previous Article See Page 161.*)

A complete list of the machine tools of this shop was presented last month. The output in the month of February was 6 new locomotives, 32 heavy repairs of 100 per cent. engines, that is to say, engines of 20,000 lbs. tractive effort, and light repairs to 18 more. Out of 26 engines in the shops at the time of the writer's visit 17 required heavy fire box work. In the locomotive shop 1,373 men were on the pay roll last March. Of the work of the locomotive shop 50 per cent. of the labor is devoted to repairs, 25 per cent. to the building of new locomotives, 20 per cent. to manufacturing and 5 per cent. to tools and miscellaneous service. The shops were opened last August, and in December, besides the repair, 6 new locomotives were built.

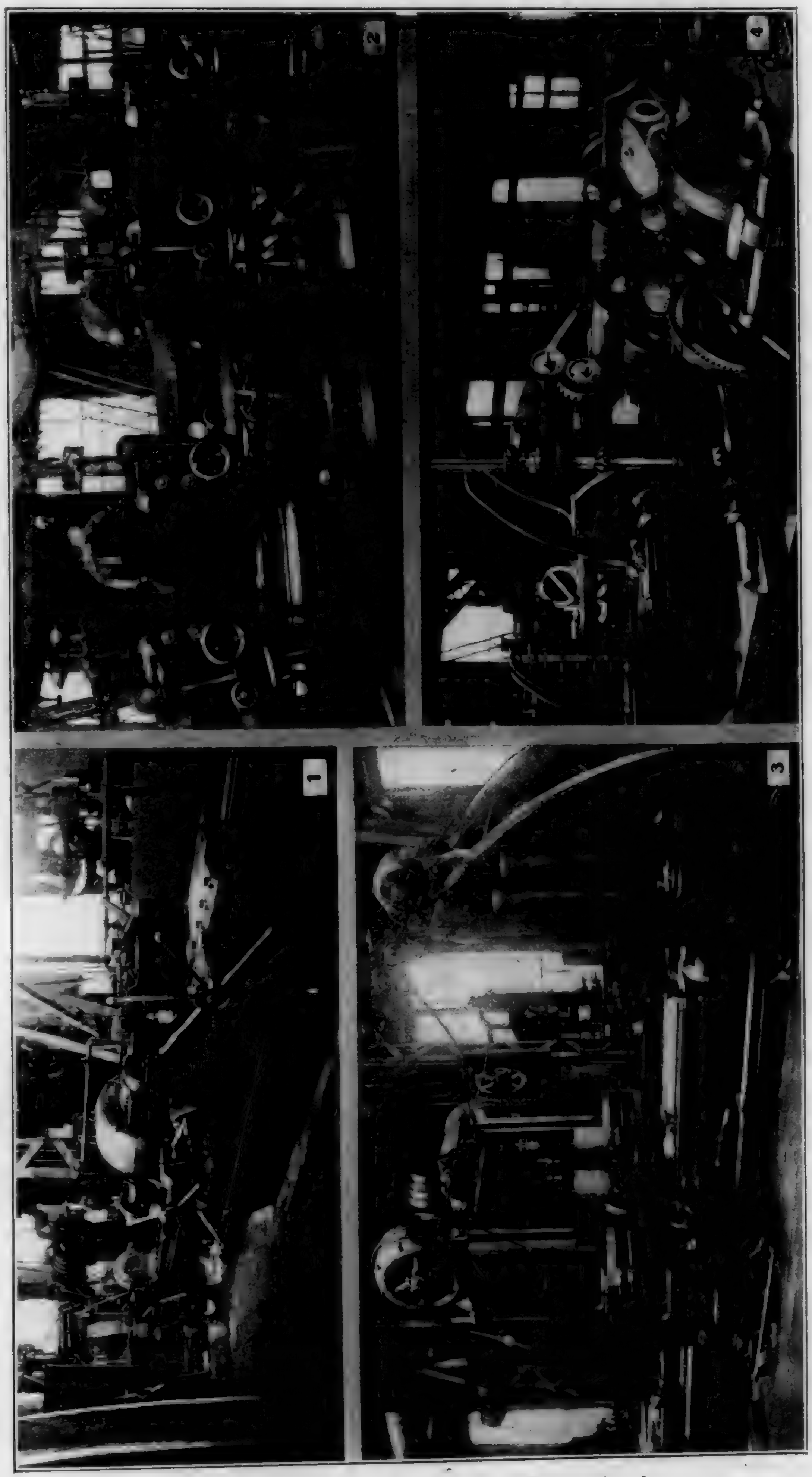
While the standing capacity of the shop is for 36 engines, 26 pits are used for repair work and 3 pits for new construction. There are 5 gangs for the 26 pits, the shop being organized on the travelling gang system. These gangs are arranged as follows:

A stripping gang has 2 pits and is divided into 2 sections of 6 men each; 6 men strip an engine and remove the wheels, the other 6 attend to the steam chests, cylinders and general stripping. These men do all the stripping in the shop and do nothing else. There are 3 general repair gangs for heavy repairs; 1 gang for light repairs and another gang for miscellaneous work, such as steam shovels and rotary snow ploughs. In each of the repair gangs there are 8 fitters, 4 apprentices and 1 helper. The light repair gang attends to such repairs as are made without taking an engine off its wheels. The new engine gang consists of 14 fitters, 2 apprentices, 2 drillers, 2 boys and 1 helper. Floating gangs are arranged as follows:

Three fitters and 1 apprentice attend to all the steam chest and valve gear work except that of new engines. The motion gang consists of 1 fitter and 2 apprentices. The steam pipe gang, 4 fitters and 1 apprentice. Shoes and wedges are attended to by a gang of 4 fitters and 2 apprentices. The brass mounting work is done by 3 fitters and 1 apprentice. One man takes care of all the air pumps and accessories. One man and an apprentice looks after the guides. One man and an apprentice set all the valves in the shop. A gang of 3 fitters and 2 apprentices is responsible for the braking and spring gear. As a general rule, each gang has 6 engines.

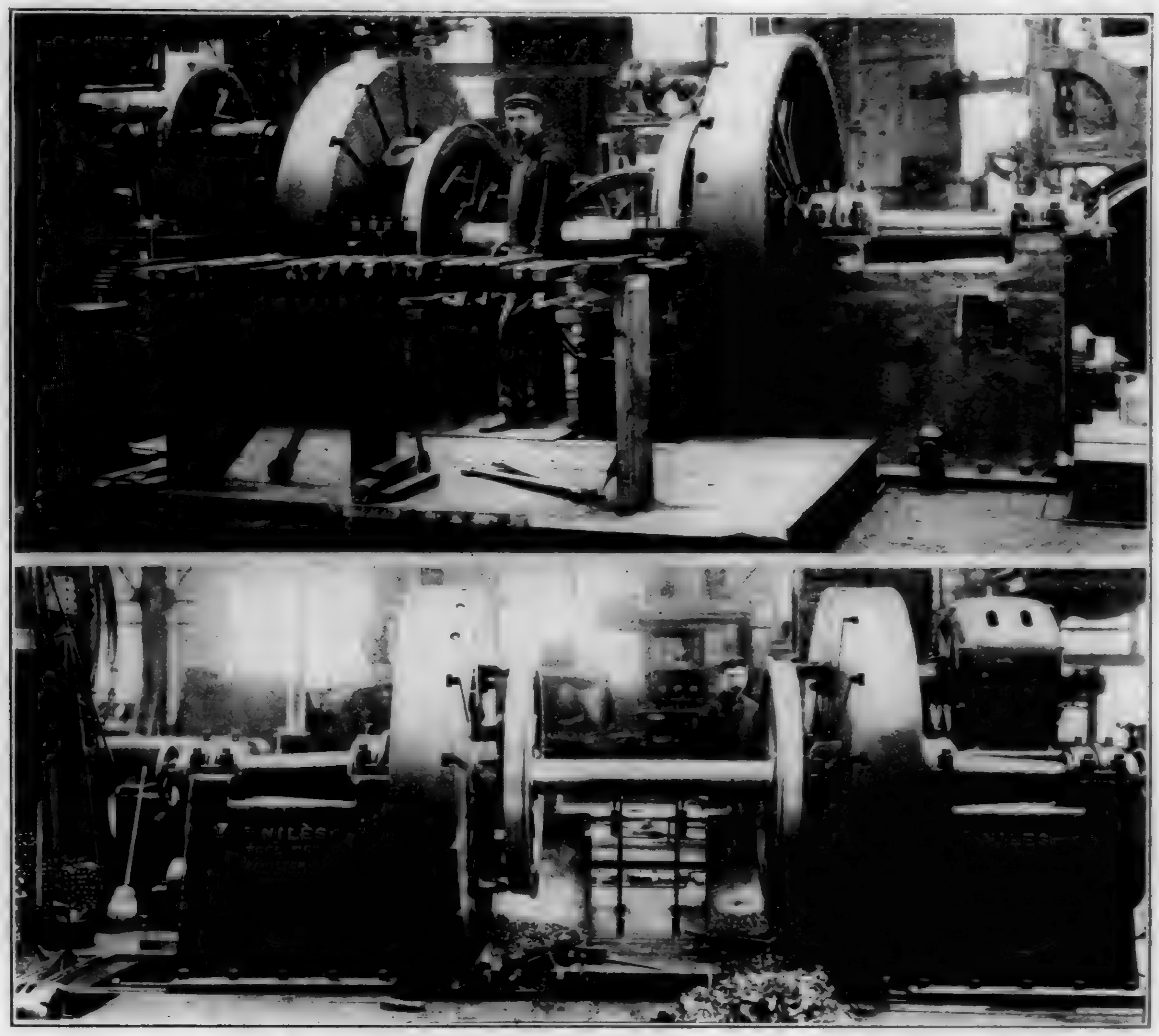
The pace of this shop is a good, healthy one, and blue chips are seen in abundance, in fact more generally than in any railroad shop the writer has visited. The shop management does not aim at record breaking, but rather to attain a good "gait" of the shop and extending even into corners. The erecting shop foreman meets the sub-foremen in his office every morning and shows them the costs of the previous day, the figures being ready for him. Period statements are discussed by the foreman on the 7th, 14th, 21st and last day of the month, or days corresponding nearly to these, the figures being arranged during the week to show the actual cost of the work. A daily progress report is made on each engine and a shop schedule will be introduced in the future. Reasonably cheap rather than very rapid output, a steady business-like pace instead of a variable one, is the object sought. The actual costs are closely watched, in such a way as to inspire the foremen with the importance of the commercial question involved. This shop has a department for providing jigs, templets, and the supply of labor-saving appliances for setting and holding work in the machines surpasses that of many shops which have been running for many years.

Mr. Vaughan's method of keeping locomotive repair records has undoubtedly much to do with the commercial view of the



MACHINERY IN ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

(1) BARDONS & OLIVER 5-IN. TURRET LATHE.
(2) BEMENT-MILES FRAME DRILLS.
(3) POND DOUBLE HEAD PLANER.
(4) BEMENT-MILES CYLINDER BORER.



90-INCH NILES WHEEL LATHE.—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

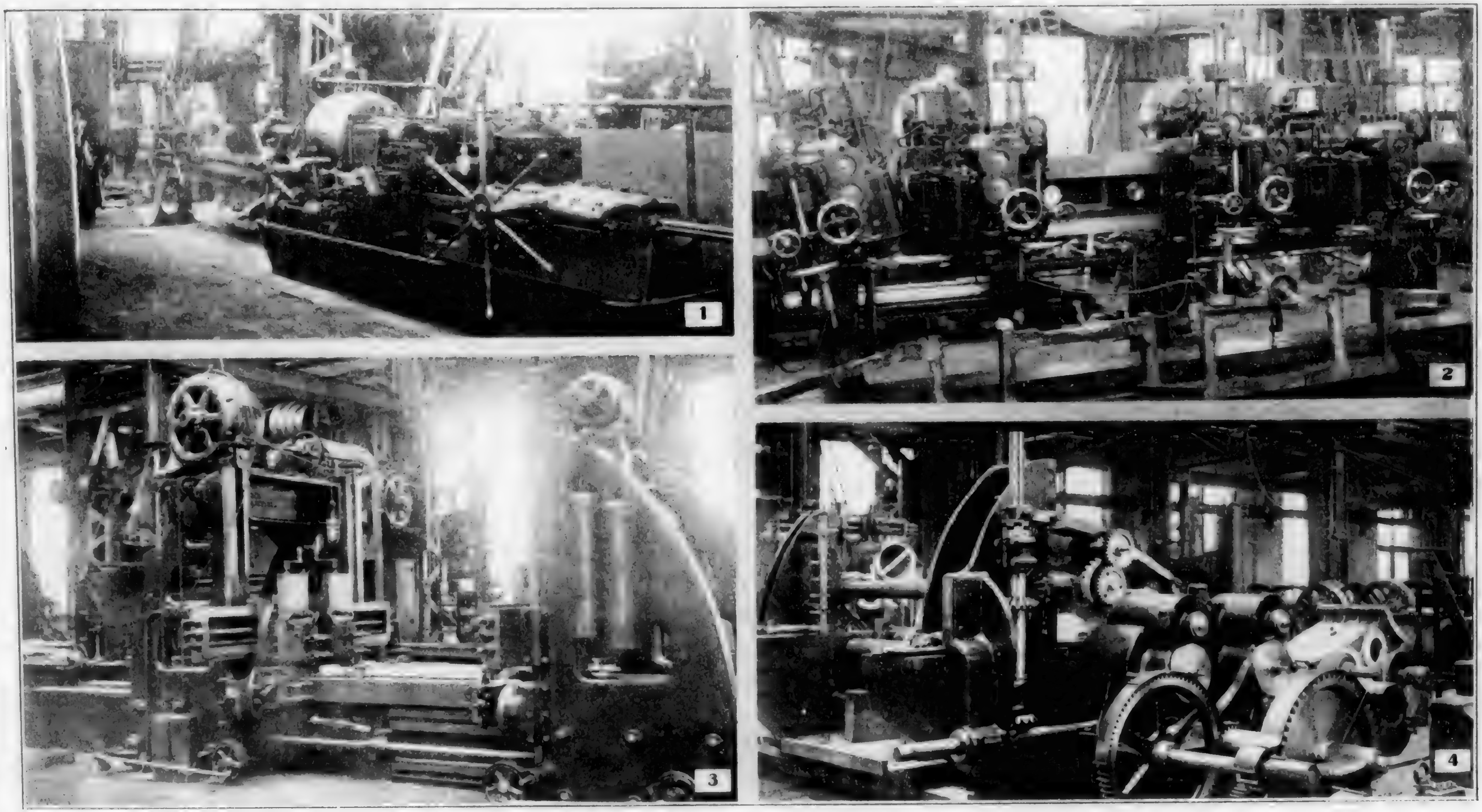
shop taken by all of the foremen. His article in this number explains this system fully. It seems to lead the road men to measure their work in terms of mileage and the shop men to measure theirs in dollars and cents. Such comments are certainly appropriate in describing these shops, because the completion of the plant itself is considered as only the beginning, and too often a new plant is deficient in organization for a long time after its completion.

The brass department in the gallery is worthy of more space than can be given here. An example of the work done will suffice to indicate the character of its management. Mud plugs are made in an ordinary Warner and Swasey turret lathe in three sizes from 2½ ins. to 2¾ ins. at the rate of 30 per hour. They are made of brass. A forming tool cuts the taper and the threads are cut by a collapsing die with a taper attachment, this having been developed in this department. There is no difficulty with leaky mud plugs.

The small as well as the large machines throughout this entire shop are running at a pace which gives an impression of activity not too often found in railroad shops.

It is the opinion of the writer that a larger proportion of variable speed drives would have been advantageous. As seen in the list of machinery printed last month, the direct current variable speed drives, or independent motors, are confined to a 90-in. mill having three motors; Bement-Miles milling machine; cylinder borer; 60-in. Niles boring mill; locomotive frame drill; double-head shaper and two small boring mills, a total of eight machines. In addition to these the 90-in. Niles wheel lathe, the cylinder planer and three-head slotter have A. C. so-called variable speed motors.

Ninety-Inch Niles Wheel Lathe.—This lathe, driven by a 30-h.p. induction motor and driven by a Morse chain, is supposed to have from 40 to 50 per cent. speed variation in the motor at full load. The actual variation, however, is limited to about 13 per cent. This machine is illustrated in the engraving. The motor is likely to be changed. This machine is capable of maintaining the tires of 700 locomotives and to turn the tires of 5 consolidation engines in 5 days. An average of 6 pairs of 57-in. wheels with Krupp tires have been turned at the rate of 1 hour and 15 minutes per pair for the actual cutting time. Two pairs of 84-in. wheels have been turned in 4 hours and 10 minutes. The secret is that this is a heavy, strong, large-journaled machine, with a total weight of 50 tons, the work being held close to the tool by improved devices. The machine turns out 5 pairs of from 55 to 62-in. tires per day, 2 hours per pair representing the work which it will do regularly. Cutting speeds of about 12 ft. per minute are used, and the machine will take all the cut there is to take on a worn tire at a ¼-in. feed. The machine is designed for taking cuts ½ in. deep, 3-16 in. feed, with a cutting speed up to 30 ft. per minute. The main drive motor is of 30 h.p. capacity, and the motor for traversing the head of 3 h.p. capacity. The face-plates are driven by internal gears, the pinions which drive them being driven by intermediate gears, thus increasing the speed of the main driving shaft. As this driving shaft runs at 3 to 4 times the speed, and is of larger diameter than that usually furnished on driving-wheel lathes, its torsion is therefore very much reduced, making the drive of each face-plate steady under the heaviest cuts. The patented driving dogs permit the full power of the machine to be utilized at the tools allowing as heavy cuts and high speeds to be used as the tool



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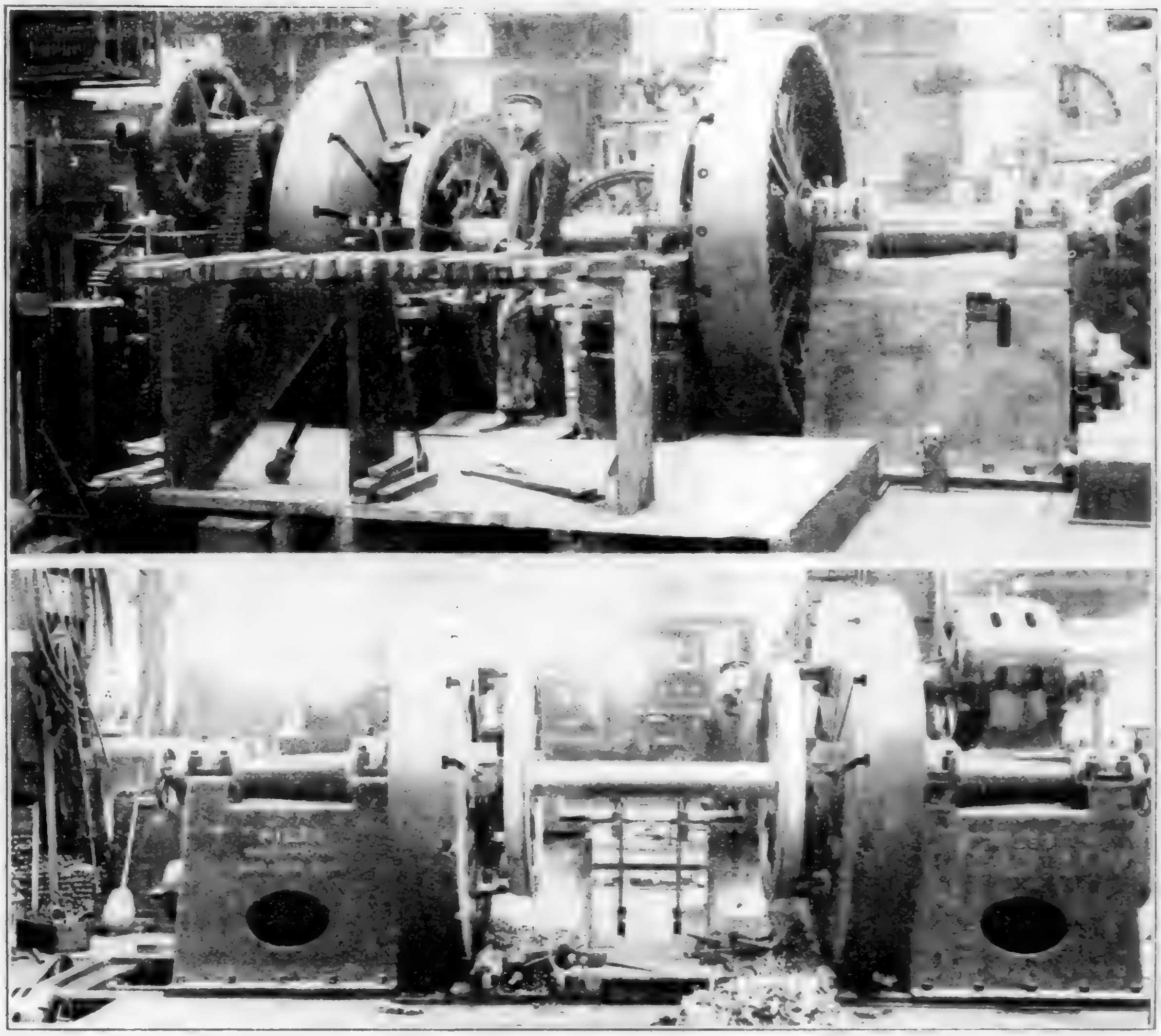

90-INCH NILES WHEEL LATHE—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

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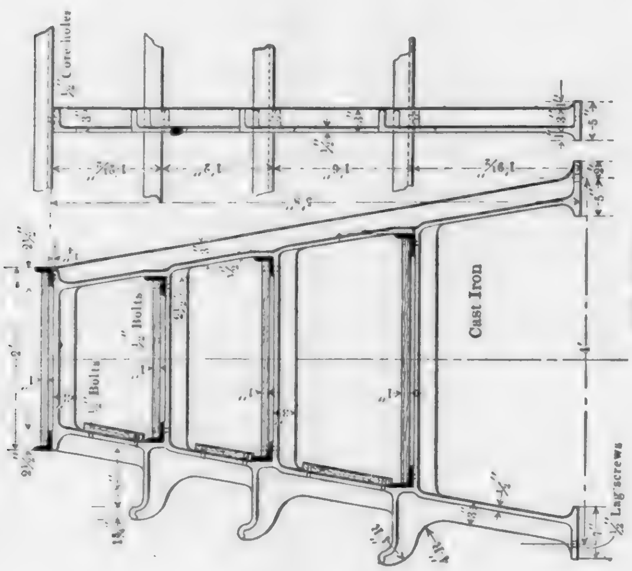
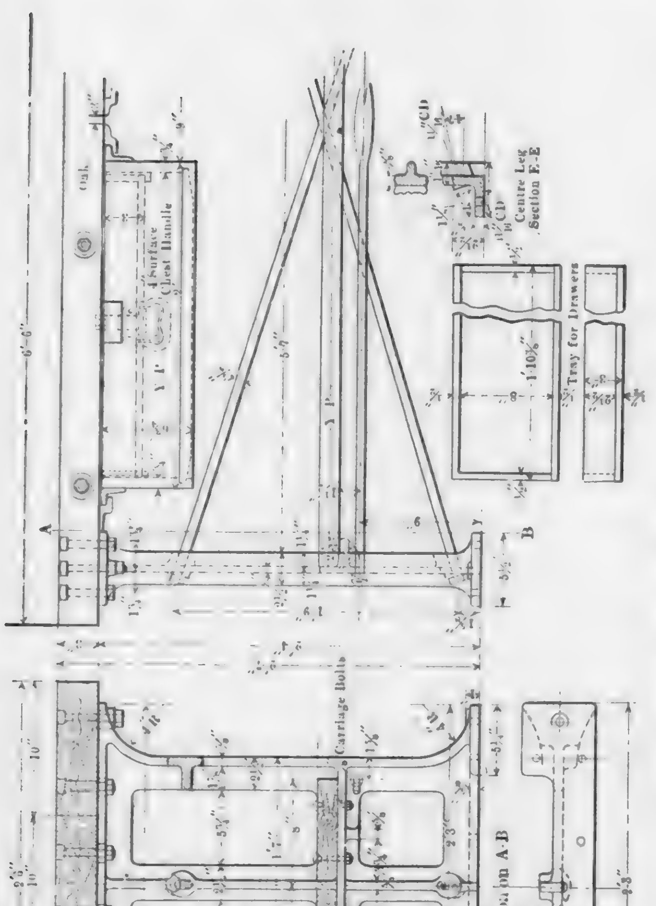
steel will stand. The photograph shows clearly the application of these dogs. The dogs are arranged at sufficient distance from the face-plates so that all drivers but those having the main crank pin on them can be put in without moving the movable head. On wheels which have the main crank pins, the movable head is traversed out, the wheels put in



ROD RACK.



WORK BENCH USED IN SHOP DEPARTMENTS.

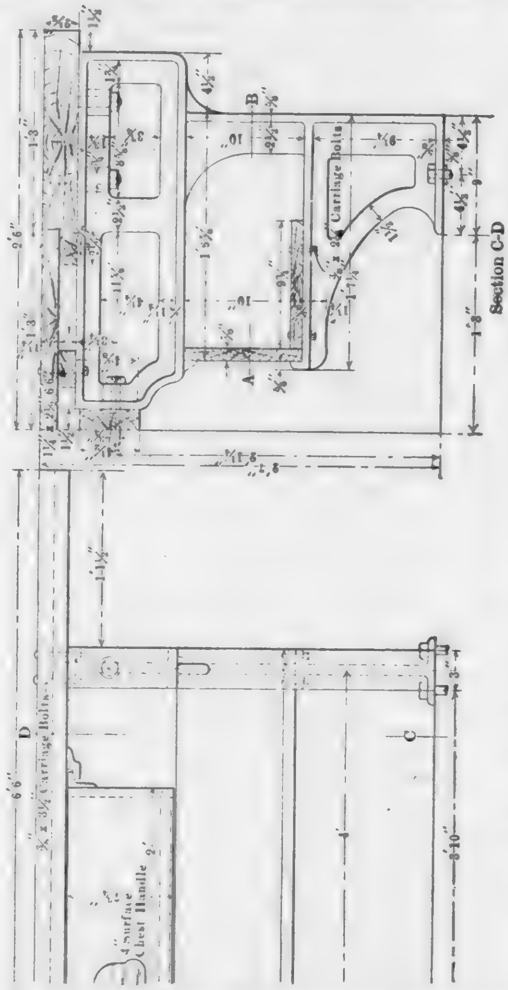
place and the crank pins inserted in the holes in the face-plate and then the movable head moved up.

Tire Boring.—Tires averaging about 62 in. in diameter are bored at the rate of 12 or 13 per day, averaging more than 1 per hour. This is done on an old Craven boring mill, the mill being 20 years old. Thirty-four-in. truck tires with 2 retaining rings are finished at the rate of 11 in 10 hours on two smaller mills, one of the mills being a Bullard and the other a Niles, shown in the list of machinery last month.

Slotting.—An old 12-in. slotter, 22 years old, slots 12 cast iron driving boxes for the brasses per day of 10 hours, the size of the axle being 8½ ins.

Frame Planing.—The Shanks frame planer cuts at 25½ ft. per minute and returns at 52 ft. per minute. A pair of switcher frames are planed on both sides and the top in 19 hours with a ⅝-in. cut and 7-32-in. feed. With one of the new tool steels the tool cuts across the frame with one sharpening.

Frame Slotting.—The Bertram 3-head frame slotter slots 4 switcher frames of cast steel in 50 hours, 4 iron frames are



WORK BENCH FOR SHOPS AND ROUNDHOUSES.—CANADIAN PACIFIC RAILWAY.

slotted in 30 hours. The slotting work is done in about half the time of the planing. The slotter has a stroke of 26 in.

Rod Planing.—A Pond double-head rod planer is equipped with a 15-h.p. motor for the main drive, which is not sufficiently powerful. Four Laird guides, 7 x 2¾ in the rough, are planed at once and finished to 6¼ x 2⅜ in. in four hours.

Shaper.—The 2-head Bertram shaper is driven by a 25-h.p. D. C. variable speed motor with a speed variation of 2 to 1. It cuts ⅝ x 1-16 ins. at 23 ft. per minute on rod work, and this is fairly within the capacity of the machine.

Some of the more interesting of the new machines and their motor drives are illustrated in the accompanying photographs. The work benches of the machine shop and the rod racks referred to in the May number are also illustrated.

The Stolze Gas Turbine.—Dr. Stolze of Berlin has been at work since 1873 upon a gas turbine, and is now building one of 200 h.p. According to the *Engineering Review*, the experimental machine consisted of two separate turbines mounted on a common shaft, one acting as a rotary air compressor and the other being the turbine proper.

INTERNATIONAL RAILWAY CONGRESS, WASHINGTON, D. C.

The seventh meeting of this international association of railway officials was opened May 4 at the New Willard Hotel, Washington, D. C., by an address by the Hon. Charles W. Fairbanks, vice president of the United States. The speaker commented upon the fact that the great development of railroad transportation had been compassed by the lives of many men now living. Beginning locally to serve small needs, it had become the artery of political and commercial affairs of the world. His address was a fitting tribute to transportation as a civilizing, developing, unifying influence, making for universal friendship, fellowship and peace.

Mr. Gerard, president of the permanent commission of the Congress, followed, stating that 70 years ago Belgium opened its first public railway in 1834 (which, by the way, was two years after the AMERICAN ENGINEER was founded). To-day that little country has 4,515 miles of railways, covering a territory of 11,500 square miles, this development, measured by the size of the country being greater than that of any other country in the world. To Belgium also belonged the credit of inaugurating the International Railway Congress. Personifying the traditions of the organization, the speaker thanked the United States for its interest in the organization. From the first meeting Mr. E. T. Jeffrey of the Denver & Rio Grande had attended all conventions of the Congress. Mr. Gerard spoke of the work before the organization consisting of 20 subjects and 47 reports.

Mr. Stuyvesant Fish, president of the Illinois Central Railroad, as president of the American Railway Association, welcomed the Congress to this country for the first time it had ever met outside of Europe. This meeting also was the first to which German government delegates had been sent. Mr. Fish gave a prominent place to John Ericsson in the development of the locomotive and noted that his death occurred as recently as 1889. Great Britain had been the birthplace of railroads, but the United States had brought about their greatest development. In the United States three-quarters of the country depended absolutely upon railroads for its settlement. Mr. Fish presented many important statistics to compare units of service showing what our railroads had accomplished. This interesting address merits more space than may be given to it here.

REPORTS OF THE SECTIONS.

LOCOMOTIVES AND ROLLING STOCK.

Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio, was the reporter for the United States on this subject which treated of the increase in the power of locomotives by the adoption of high pressures and of the compound principle. The conclusions of his paper were as follows:

1. Locomotives of great power, within the present gauge, clearance and weight limits, may be designed and constructed to remain effective for several years and produce a higher average speed and tractive power with less cost for locomotive expenses per unit of power developed, than that given by locomotives of large capacity in use to-day or from the previous lighter equipment.
2. The efficiency and economy predicted and anticipated from the use of locomotives of great power have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy.
3. Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes which continued and practical experience may have determined to be more suitable and interchangeable than the standards of locomotive builders.
4. The present dead weight should be reduced by the use of design and material which will combine the least weight and greatest desired strength.
5. The elimination of those individual preferences and devices, more or less visionary, which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results.
6. The motive power department supervision has often been curtailed when extension of organization and direct oversight should have been given to insure the desired performance. Changes in organization and methods have frequently been made in preference to technical education and advancement for the deserving rank and file.
7. The locomotive maintenance and dispatch facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing delay at terminals during a period when more opportunity for maintenance and handling has been essential.
8. The tonnage hauled per train has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive movement.
9. Decreased efficiency has resulted from the irregular transferring and changing of crews of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results.
10. Provision for the cleanliness and care of employes and equipment on the line and at terminals, should receive more consideration.
11. Personal supervision and investigation should govern in the construction and operation of locomotives of high power, while statistical information and correspondence should be limited and used with caution.

Mr. J. F. Deems discussed traction increases and mechanical stokers as means for increasing starting power and sustained capacity of locomotives. Other speakers took up the subject of stokers, the conclusion being that they promised good results which would justify careful experimental applications. They had not yet shown a great saving in fuel. Opinions were not unanimously favorable. Compounding received a large share of attention. The speakers clearly indicated the chaotic condition of opinion on this subject which the foreigners could not understand. Mr. Vaughan believed that superheating would give better results than compounding and based his judgment on considerable experience with 2-cylinder compounds and superheaters. Mr. A. Lovell (Santa Fe), who is operating the most powerful compound road locomotives in the world, reported results of tests showing that compounds were more economical in fuel, but slightly less so in maintenance. For heavy fast passenger trains simple engines could not do the work that was done by compounds and for the same work compounds effected savings of 20 to 24 per cent. Furthermore the boilers of simple engines cost more to repair. The increased cost of repairs of compounds was believed to be due solely to their greater power.

Mr. E. Sauvage (Western Railroad of France) presented the conclusion of his report on the same subject from a European point of view, which was briefly summarized as follows:

European designers need to be allowed at least 10 tons per wheel in order to meet the need for more powerful locomotives. He did not find that widening the gauge in Spain, Portugal, Ireland and India showed an increase of power in locomotives. It was not considered desirable to exceed 300 r.p.m. of driving wheels and about 6 ft. 6¾ ins. in diameter. Larger wheels meant heavier engines, and the effect of high rotative speed could be corrected by large ports and piston valves. The use of wide fireboxes extended over the rear wheels was desirable in Atlantic type locomotives. Pressures as high as 228 lbs. per sq. in. were used, but involved increased cost in boiler maintenance. Serve tubes were in general use abroad, but they necessitated frequent cleaning. Compounding had established itself as a factor of economy or increased power for the same consumption of fuel. Four-cylinder compounds had given good results. Two separate valve gears and separation of the cylinder efforts between two axles was preferred. Piston valves were again favorably mentioned. Tail rods were recommended for cylinders 19 ins. in diameter and longer. By use of high pressures and compounding 1,900 h.p. could be obtained within present limits of weight. Eight-coupled locomotives were favorites for freight service, but they are limited to about 22,000 lbs. tractive power because of the weakness of European couplers.

Mr. Moffre (Midi Railway, France,) stated that French engineers strongly favored compounding. Simple engines after being converted into compounds with the same boilers showed an improvement of 20 per cent. in economy of fuel. He believed 4-cylinders to be desirable even if superheating succeeds compounding. Crank axles were not worried about in Europe, where they were making mileages of over 350,000 miles without developing cracks. Mr. Karl Steinbiss (Prussia) stated that 1,000 Von Borries and Mallet compounds were giving good results in that country. An average gain of 10 per cent. in fuel was found and practically no increase in cost of maintenance. Great things were expected from super-

heating. German engines were limited to 8 tons per wheel. Mr. A. W. Gibbs (Pennsylvania) gave excellent reports of the performance of the De Glehn compound on that road. Mr. Laurent (Paris-Orleans Railway) admitted that staybolts were troublesome in France. Manganese bronze substituted for copper was an improvement, but a still better metal was sought. The same trouble had been experienced with American engines in France and was believed to be unavoidable with high pressures. This speaker defended compounds from the charge of lack of flexibility. Within load limits varying 50 per cent. the fuel per unit of work did not vary 5 per cent. (He was speaking of De Glehn compounds with separate valve gears for high and low pressure cylinders.) The foreigners strongly favored compounding and this opinion was shared by Americans who had had the greatest amount of experience with this principle.

In discussing fireboxes Mr. A. W. Gibbs showed that the actual wearing of fireboxes is not as rapid as it is believed to be. With 3,300 locomotives in service, 700 of which were heavy one, not over 70 fireboxes required replacement annually and in a boiler having a life of 20 years fireboxes are usually renewed twice. Bad water and lack of care in construction were believed to be the most frequent causes of boiler defects.

The speakers frequently returned to the subject of compounding. Mr. Wright of the Great Western Railway, England, stated that the De Glehn compound on that road had covered the distance from London to Plymouth, 246 miles, without a stop. He believed that the superiority of that engine was due to its independent mechanisms. That road has ordered two other locomotives of the same type of a greater power.

Mr. M. Ronayme stated that in order to increase the capacity of locomotives on the roads of New Zealand he had ordered four locomotives of the De Glehn type, and from the remarks which he had heard at the Congress he felt sure that he was on the right track. He intended to experiment with spirally corrugated tubes in order to burn lignite fuel. Mr. Tordeux, Eastern Railway of France, stated that his road had 330 4-cylinder balanced compounds. He had had satisfactory experience with piston valves. Mr. D. F. Crawford, Pennsylvania lines, expressed a favorable opinion of piston valves, especially in passenger service.

The discussion was summed up by Mr. Muhlfeld, who stated that boiler pressures are higher in the United States than in Europe, and commented upon the slow adoption of the compound system in America, which he attributed to difficulties encountered at the beginning and to the object aimed at by compounding in this country, which was to increase capacity, whereas in Europe it was to increase economy. The speaker believed that superheating merited more attention in this country than it had received, and he spoke favorably of articulated locomotives. At the close of this discussion the following conclusions were framed and were afterwards adopted at the general meeting.

The power of locomotives is more limited in Europe than in America, owing to the lower allowance of weight per axle.

European engineers generally agree in thinking that compounding admits of the construction of engines giving the maximum power and economy.

This system utilizes the steam very well and does not appear to increase to any noticeable extent the cost of maintenance of locomotives; it does not make the maintenance of the boilers more difficult, but that is due to their increased size and higher working pressure, which are necessary in all cases. Almost all locomotives built in France in recent years have four balanced cylinders. These engines, as well as other compound engines of other systems, are also employed in other European countries, especially Germany, Austria, Spain, etc. Several engineers in Great Britain and Ireland express equal satisfaction from their use and insist on the advantage of separating the high and low pressure machinery. A number of American engineers also express opinions favorable to compound locomotives, which have given satisfactory results on the Atchison, Topeka & Santa Fe Railway; the sentiment on this matter is, however, less unanimous in the United States than in Europe. The section has been informed of experiments made in New Zealand with four-cylinder compound locomotives.

The introduction of American locomotives in Europe and European locomotives in America has had the advantage of making known on both sides some interesting details of construction, particularly the light weight of the parts of European locomotives and the syphon and sight feed lubricators of American locomotives.

The constantly increasing use of cast steel is observed, which in the United States has even been tried for cylinders.

The use of the Walschaerts motion gear is extending in the United States.

Generally speaking, all the engineers who have spoken of cylindrical valve chests appear well satisfied with them.

A number of tests of automatic stokers have been made in the United States and on the Great Western Railway of England, but as yet the results have not been definite. It has also been found, both in America and in England, that without the aid of these devices, but with proper arrangements of grates, the heaviest firing necessary at the present time can be effected without difficulty.

Finally the section has examined the use of articulated locomotives of great power on lines of irregular grades, particularly Mallet locomotives and those designed by the Nord Francais and Nord de l'Espagne railways.

Lighting, Heating and Ventilation.—The reporter of this subject, Dr. C. B. Dudley, of the Pennsylvania Railroad, presented an admirable paper discussing methods of heating, lighting and ventilating passenger trains. He described the systems in use on the Pennsylvania Railroad, which have been thoroughly presented in this journal. Mr. Max Toltz (Manistee & Grand Rapids Railroad), presented an account with figures of experiments with a system designed by Mr. Lipschutz, using compressed acetylene. Mr. W. E. Fowler (Canadian Pacific) confirmed the information given by Mr. Toltz, stating that the system was used on 36 cars on his road with very satisfactory results. The discussion by foreign delegates indicated that the problem of car lighting is generally appreciated, and that marked progress is being made. Mr. Anderson (Government Railroads of India) said that in Oriental countries electric lighting was a necessity in order to reduce heat. On the main lines of India 95 per cent. of the cars are lighted with electricity, either with dynamos at the head end of the train by storage batteries or by the Stone system of lighting from the axle. The high cost of electric lighting was mentioned by a number of speakers. In regard to heating, the information brought out is likely to be of more value to the foreign delegates than to our own. The following conclusions were adopted:

As regards lighting, the Congress notes the development of the use of incandescent mantles, heated by oil gas and sometimes by common gas, and of different systems of electric lighting. Cylindrical mantles seem to be somewhat stronger than globe mantles, but the latter distribute the light somewhat better. Various types of mantles are used in Europe by different managements, especially in France and Germany, and are beginning to extend to the United States.

Systems of electric lighting are giving satisfaction on different roads. Attention is called to their advantage in certain cases for intermittent lighting, in passing through tunnels and operating driving fans.

Acetylene gas has been used mixed with Pintsch gas, especially in France and Germany, but a tendency is observed to abandon this mixture, owing to the use of mantles. On the other hand, mention is made of the use in America of pure compressed acetylene, with some special precautions.

Steam heating has a tendency to extend in different countries. To obtain sufficient heat for very long trains, or in cases of very low temperature, care is taken either to use pipes of sufficient diameter or compressed air mixed with steam.

The adoption of a uniform coupling for all the cars in the same territory is an important question to be solved.

The Congress notes the different systems of car ventilation that have been applied, especially that in use on the Pennsylvania Railroad.

Light Railways.—After a long discussion the section dealing with this subject adopted the following conclusions:

Light railways merit in the highest degree the attention of public authorities. Their construction makes it possible to encourage the progress and development of districts which previously have remained in the background, and it is accordingly not only the interest but the duty of the governments to assist them. It is desirable therefore not to adhere to old types and old methods of construction, operation and regulation, but to introduce every facility possible, adaptable to local needs and available resources. It is also desirable that state governments and local authorities should accord to light railways, either under the form of subsidies, relaxation of requirements or other methods of assistance, the support which they need, both for construction and for operation, so that all parts of the country may be adequately served. When the authorities of a country do not themselves construct or work light railways, and turn them over to private companies, it is indispensable that the terms of the concession should be so defined as to harmonize the interests of the working company with those of the public.

Improved Frogs.—The following conclusions were adopted:

That on all main lines carrying heavy traffic with axle loadings on the locomotive of over 50,000 pounds, and with loads on the

rolling stock reaching as high as 40,080 pounds per axle, the "spring rail frog" or the "hinged spring frog" may be used with perfect safety, where the traffic on the side tracks connecting with the main track is very slight compared with the main traffic.
where the space for crossing from one track to another is limited,
That the "moveable point frogs" may be used at all termini but that where space permits, and where high speed is necessary, a series of switches, with the best designed switches and fixed frogs are preferable.

AUTOMATIC BLOCK SIGNALS.—After an intensely interesting discussion based upon wide experience of American railroads in automatic signals and the favorable opinion from Sir Charles Owen, of the London & Southwestern Railroad, the following conclusions were adopted:

That automatic signaling properly designed and installed be recognized as a suitable means of protecting train and switching movements.
And notes that there has been much improvement and extension of the automatic signaling since the last Congress, and that those who have used it have found it effective for their purpose.
The Section is not prepared to recommend automatic block signaling for general adoption to supersede existing systems, but they consider there are many cases where it has special advantages.

POOLING LOCOMOTIVES.—This subject was reported upon by Mr. G. W. Rhodes for the United States and Mr. Hubert and Mr. Boell for foreign railways. While the discussion drifted into considerable detail, very little was said which can help the United States in its problem. It was evident that the speakers desired to retain individual responsibility of the enginemen and at the same time secure proper mileage from the locomotives. The following conclusions were accepted:

The Congress finds that in Europe and in countries other than North America the general sentiment is very much in favor of the single crew system and unfavorable to complete pooling, which is only used when necessitated by a sudden increase in traffic. However, for certain services various combinations of double or multiple crews or of mixed crews are used according to circumstances.
In North America pooling is, on the contrary, very general, though little used for passenger service, and a tendency to using single crews is generally manifest.
It is, however, in place to remark that the organization of train service depends to a large extent on local conditions.

AUTOMOBILE CARS.—As a result of the discussion of this subject in several sections the following conclusions were adopted:

The simplification of the service on lines which carry little traffic has a general interest for all railways operating such lines. The Congress expresses the wish that the present tendency of a legislation to establish more liberal regulations for lines with little traffic and light trains may become more general, and that the efforts of the managements to equip their light traffic lines with a more economical organization, which promise to give remarkable results, be continued. The simplifications introduced in maintenance of way, stations and trains, as well as the introduction of automotor cars on different lines, merit commendation.
While recognizing that the technical side of the question of automotors, as applied up to the present time, are capable of improvement, the Congress expresses the opinion that experiments with this method of transportation should be continued.
It is desirable that this important question should not be lost sight of and that the International Commission should incorporate it in their programme for the next meeting.
Experiments with automobile cars and with automotors hauling trailers have been numerous during the last few years to an important extent, both for use on lines with little traffic and for use on busy lines, and it may be expected that from now on these cars will constitute a valuable means of transportation, which on some lines will have a great future.
It does not appear doubtful that, owing to the saving of an employe in the driving, to the material reduction in the cost of traction, to the probable reduction in the cost of maintenance, to a better utilization of the rolling stock, to the smaller extent of station installations required, perhaps also owing to less wear of the rails, automobile and automotor cars will make it possible materially to reduce the cost of working lines with little traffic and will in the cases of other lines result in a material improvement in the working of some classes of service. Their use will certainly effect a change in the system of operation in the case of a great number of lines and appears to have a real future before it.
The period of actual operation has, however, only just begun, and definite economic results cannot yet be clearly discerned in favor of a given type of motor or of a given system of working.
It is desirable that railway managements should continue their experiments in this direction and more especially investigate the classes of service to which this new motor is suitable, and the advantages it offers the public and the railway managements, particularly in the matter of cost.
Finally, it is important that any changes recognized or which may be hereafter recognized, as likely to facilitate the advantageous use of automobile and automotor cars should be introduced into the regulations in force.

ELECTRIC TRACTION.—The discussions on three elaborate papers on this subject brought out many interesting facts of experience, including figures of cost and opinions concerning various systems including single phase. The most important feature of the discussion was the expression from Mr. J. A. F. Aspinall, general manager of the Lancashire & Yorkshire Railway, based upon the experience of the electric line between Liverpool and Southport. He stated that electric traction was not adopted by that line to save money, but to make money. In twelve months of service the results have been very satisfactory as to increase in traffic, but the operation is more expensive than with steam. While the cost of coal per ton mile is greater, running expenses are less because of greater mileage by the crews. One reason for adopting electricity was to increase the capacity of the Liverpool terminus. For steam four switch and eight signal operations were required for each train, which were reduced by electricity to two switching movements and four signal operations. Electric traction costs more than steam, but judging from Mr. Aspinall's remarks, the gain in traffic more than compensated for the increased investment. The foreign delegates presented valuable experience in the operation of a number of lines of comparatively heavy service.

The Congress closed on May 14 after the most successful meeting in its history.

TEST OF THE NEW YORK CENTRAL ELECTRIC LOCOMOTIVE.

On April 29 an informal test was made on the experimental track at Schenectady in the presence of Mr. W. J. Wilgus, vice president, and Mr. E. B. Katte, electrical engineer, of the New York Central, and Messrs. E. W. Rice, Jr., W. B. Potter and A. F. Batchelder, of the General Electric Company, to ascertain the relative acceleration and speed characteristics of the electric locomotive 6000 and Pacific type locomotive 2797. The test took place between 8 a. m. and 1 p. m.; the temperature averaged about 50 deg. Fahr.; the weather was cloudy but no rain fell and the rails were dry.

The experimental track is six miles in length, has 80-lb. steel rails with 6 bolt 36-in. splices, 16 yellow pine ties to the 30-ft. rail, gravel ballast well surfaced and curves elevated for a speed of about 70 miles per hour. Starting from mile post 162, where the experimental track begins, the grades in a westerly direction are as follows: Rising grades of 0.11 for about ½ mile; 0.13 for 1.84 miles; 0.07 for 1.04 miles; 0.20 for 0.38 mile; 0.32 for 0.28 mile; 0.14 for ½ mile, and down grades of 0.12 for 1.09 miles and 0.35 for about .4 mile. There are seven curves varying from 0 deg. 48 min. to 2 deg. 17 min., the maximum length of tangent being 7,565 ft. between mile posts 163 and 165.

The working conductor consists of a top-contact 70-lb. steel rail reinforced with copper and covered in part with a board protection. At four crossings overhead construction is used to cover gaps where the use of the third rail is inadmissible. Experiments are about to be started with a new type of under-contact rail which it is believed will cure many of the evils of the ordinary top-contact third rail.

The total weight of the electric locomotive is 200,500 lbs. and that of the steam locomotive and tender is 342,000 lbs. The 8-car electric train, including the locomotive, weighed 513.6 tons, while the 8-car steam train, including the weight of the locomotive and tender, weighed 513 tons. The 6-car electric train weighed 407.5 tons and the steam train 427 tons, the weight of the locomotive being included in both cases.

The average voltages during acceleration were as follows:

Runs.	Series.	Series-Multiple.	Multiple.
A	520	540	325
B	620	520	275
C	600	540	330
D	680	680	515
E	650	600	420
F	600	620	455

Due to the restricted cross-section of conductors the voltages dropped during acceleration considerably lower than will obtain in actual practice within the electric zone in the vicinity of New York, and the results obtained in this comparative

test are much less favorable for the electric locomotive than will be secured in actual practice.

RUN A.—Both 8-car trains started together with the steam locomotive accelerating faster than the electric locomotive, due to the abnormal drop in voltage from the pressure at the station of 700 volts to a track voltage as low as 325 volts. At 3,000 ft. from the starting point the electric locomotive gained the same speed as the steam locomotive, and from that point accelerated more rapidly, so that at a distance of 2 miles from the starting point the electric locomotive passed the steam locomotive, and at the shutting off point was two train lengths ahead. The maximum speed of the steam locomotive was 50 m.p.h., while that of the electric locomotive was 57 m.p.h.

RUN B.—This run was made under the same conditions as run A with results practically the same, except that the speeds were higher, as follows: Maximum speed of steam locomotive, 53.6 m.p.h.; electric locomotive, 60 m.p.h.

RUN C.—This run was made with the 6-car trains and owing to the very low voltage which during acceleration fell as low as 330 volts, at first the steam locomotive accelerated more rapidly, but at the end of about a mile the electric locomotive overtook the steam train and continued to forge ahead until the power was shut off. Maximum speed of electric locomotive, 61.6 m.p.h.; steam locomotive, 58 m.p.h.

RUN D.—In order to secure as nearly as possible results comparable with the conditions of voltage that will obtain in the actual operating zone, this run with the 6-car trains similar to those used in run C, was started at a point nearer the sub-station, near mile post 164. For this run the electric locomotive from the first turn of the wheels accelerated faster than the steam locomotive and at a distance of 1,500 feet from the starting point the electric locomotive led by a train length.

RUN E.—This run was made with the electric locomotive and one coach, a maximum speed of 79 m.p.h. being attained.

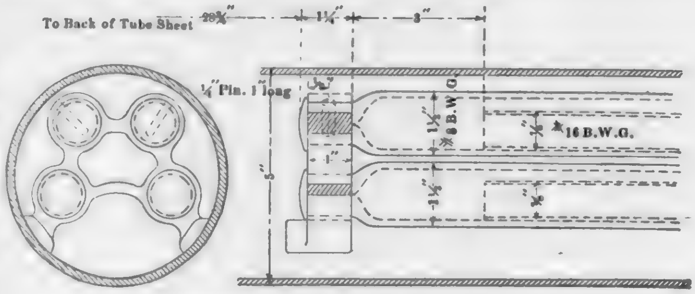
RUN F.—This run was made with the electric locomotive running light and with the power shut off on curves, a maximum speed of 80.2 m.p.h. being attained. (Speed test on May 1 reached 85 m.p.h. with a limitation on the 2 deg. 17 min. curve of 78 m.p.h.)

At all speeds the smooth riding qualities of the electric locomotive were very noticeable, especially the lack of nosing effects. After the runs the track was carefully examined and no tendency to spread rails was discovered. However, on the sharper curves the high speeds caused the track to shift bodily on the ballast, due to insufficient super-elevation of the outer rail. The most important test is run D, as the voltage during that test more nearly approached the conditions that will be obtained in the electric zone. Therefore the following comparison of the steam and electric locomotives based upon the results of this run are very interesting as illustrating the marked superiority in the acceleration of the electric locomotive over the steam locomotive, considering the fact that the Pacific type of steam locomotive has practically the same weight upon the drivers.

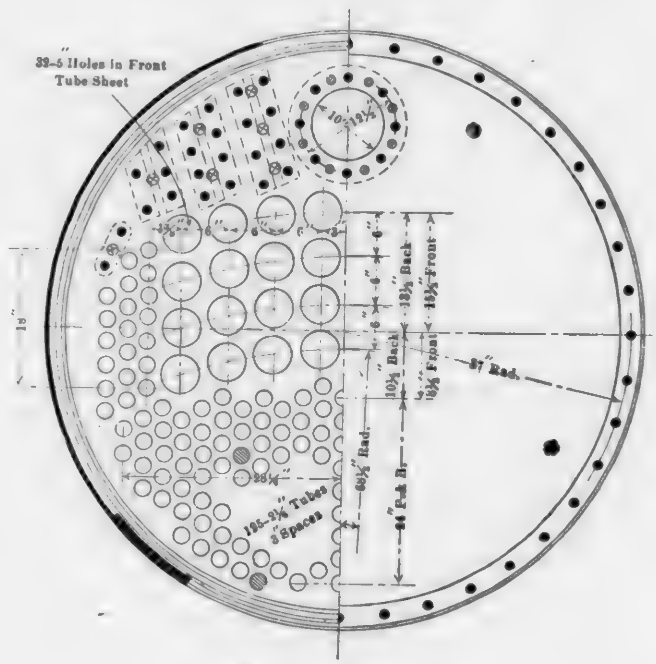
	Steam.	Electric.	Difference in favor of Electric.
Length over all, ft. and ins.	67 7¾	36 11¼	30 8½
Total weight (including tender for steam locomotive), lbs.	342,000	200,500	141,500
Concentrated weight on each driving axle, lbs.	47,000	35,500	11,500
Revenue bearing load back of locomotive, tons	256	307.25	51.25
Acceleration M. P. H. P. S. average up to 50 M. P. H.	.246	.394	.148
Time required to reach speed of 50 M. P. H., seconds	203	127	76

We are indebted for this information to Mr. Edwin B. Katte, electrical engineer of the N. Y. C. & H. R. R. R.

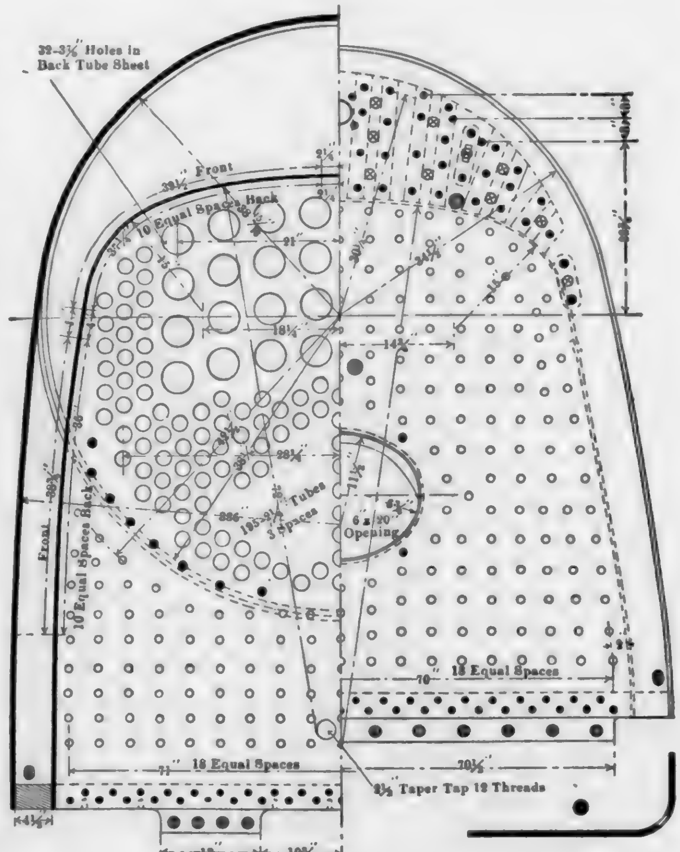
FAST PASSENGER RUN.—On May 14th, a special train of 3 coaches weighing 233 tons, made the run from Philadelphia to Atlantic City over the Atlantic City Railroad, a distance of 55½ miles, at an average speed of 74.8 m. p. h. The return run was made at the rate of 78.3 m. p. h. with two coaches.



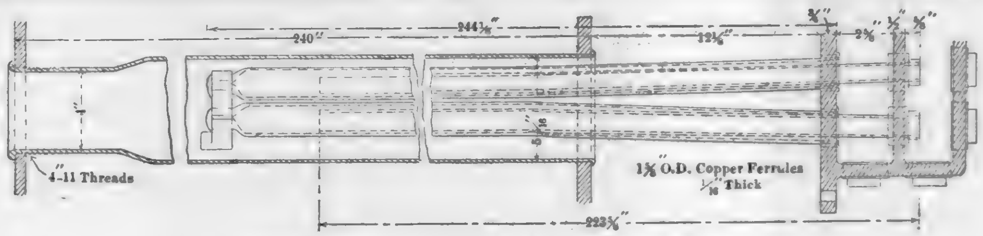
SUPPORTS FOR SUPERHEATER TUBES.



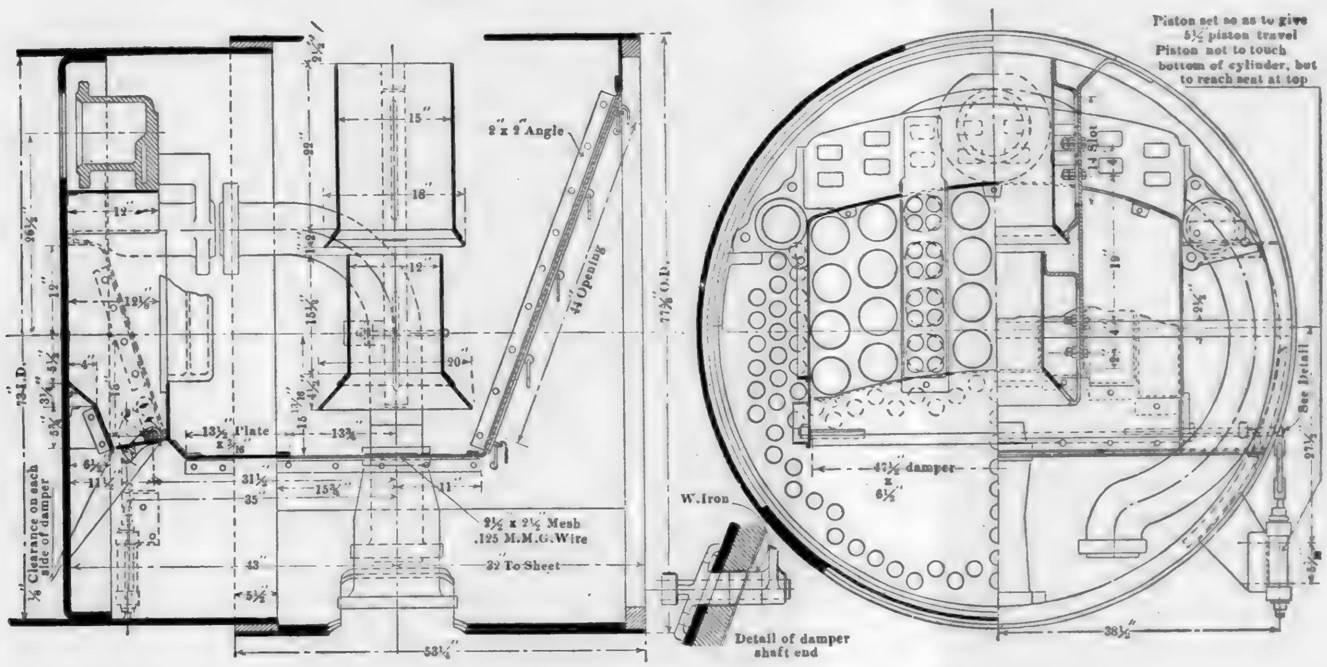
FRONT TUBE SHEET.



COLE'S NEW LOCOMOTIVE SUPERHEATER.



SHOWING ARRANGEMENT OF SUPERHEATER TUBES.



COLE'S NEW LOCOMOTIVE SUPERHEATER.

ERIE PACIFIC TYPE LOCOMOTIVE, WITH SUPERHEATER.

This is the heaviest locomotive of its type. Last month, on page 172, a photograph and table of leading dimensions was presented, and as the superheater, applied to two of three locomotives of this class now running, is specially interesting, because of its large capacity (763 sq. ft.), it is illustrated in detail.

The superheater tubes are contained in 32 large flues 5 ins. in outside diameter swaged down to 4 ins. in diameter at the back tube sheet and enlarged to 5 1-16 ins. in diameter at the front tube sheet. The superheater tubes are in four sets, extending to within about 30 ins. of the back tube sheet. The outer tubes are 1½ ins. outside diameter and of 8 B. W. G. They are secured to malleable iron saddles, which are seated in the large tube, the construction being shown in the engravings. The ends of the outer tubes are forged down and closed by welding to fit these castings. The inner superheater tubes are of pipe ⅞ in. outside diameter and No. 16 B. W. G. It will be observed that this arrangement differs from that previously used by Mr. Cole, although the principle is unchanged. The engravings show the headers, the groups of tubes and the arrangement of the front end.

References to previous articles on locomotive superheaters appear in this journal as follows: The Schmidt smokebox superheater, November, 1902, page 340; Schmidt fire tube superheater, September, 1903, page 317; Cole superheater, September, 1904, page 338, and December, 1904, page 456.

By comparison of these drawings the improvement by Mr. Cole, whereby he greatly increases the heating surface of the superheater in the case of the Erie locomotive, will be at once apparent.

These locomotives are actually hauling 600-ton trains from Jersey City to Port Jervis, 87 miles, in 130 minutes, over a hilly road. From Jersey City to Paterson, 16 miles, there are 2½ miles of grade at 27.6 per mile. From Paterson to Sterlington there are 8 miles ranging from 29 to 57 ft. per mile. From Sterlington to Chester there are 16 miles of up grade varying from 12 to 47 ft. per mile, with 5 miles of down grade before reaching Chester. From Chester to Otisville the first 8 miles are undulating, and 14 miles are up grade, varying from about 26 ft. to 60 ft. per mile, the average grade for this distance being about 1 per cent. At Middletown, 66¼ miles from Jersey City, a stop is made on a grade of about 25 ft. per mile, which is a very difficult starting point for a train. The train hauled by engine No. 2512 on April 24th was started without taking slack. The highest point reached on the division between Jersey City and Port Jervis is near Otisville, and at an elevation of 899.5 ft. above mean low water. From Otisville to Port Jervis the grade is downward for 11 miles, and Port Jervis is 432 ft. higher than the Jersey City terminal. The total length of this engine from the pilot coupler to the tender coupler is 78 ft. 5 ins., and is believed to be the longest passenger locomotive. The leading dimensions were printed last month. The tender provides for 8,500 gals. of water and 16 tons of coal. It has been predicted that no passenger locomotive could be built to perform this service, but on the date referred to it was done with ease by one of these locomotives without a superheater.

RAILROAD REPAIR SHOP MACHINERY.

The suggestion made by Mr. M. K. Barnum in his paper on "A Plan for Maintaining Railroad Repair Shop Machinery," read before the Western Railway Club and reprinted on page 133 of our April journal, that each railway shop establish a machinery depreciation fund for maintaining the machinery in a high state of efficiency by making a yearly allowance of 5 per cent of its value, met with the hearty approval of the members of the club. The suggestion was made during the discussion that in addition to the 5 per cent. to replace old tools, a yearly allowance of about 2 per cent. be made to provide for improved facilities and increased output.

That motive power officials are becoming impressed with the importance of the matter of production improvements is shown by the way in which the discussion shifted to that phase of the question. Mr. Harrington Emerson stated that, "except increase of profitable traffic and economical purchase, use and handling of stores and materials, there is nothing in railroad operation that will so immediately yield large gains as perfect control of shop and repair details, bringing methods first, machines next and men finally up to a high degree of efficiency." He also said that improved tool holders have reduced the value of alloy steels on a single lathe from $117 to $23, and that in their small tools and steels, with a better and larger supply of tools and steels, savings of nearly $3,000 a month had been brought about.

Mr. W. G. Symons called attention to a shop which gave an increased output per month from 57 to 71 per cent. and a decreased cost per engine of from 14 to 26 per cent., these results being largely due to the introduction of the premium plan among the shopmen. Mr. H. T. Bentley stated that in a certain shop, by improving the organization and methods, adding new tools which were carefully selected, and speeding up all around, a schedule of 22 days was made for work which formerly took 60 days. Mr. J. A. Carney spoke of a shop where the output had been increased over 100 per cent. by the addition of a few tools and modern appliances.

VERTICAL MILLING MACHINES IN RAILROAD SHOPS.

Some idea of the great variety of work which may be done to advantage on a vertical milling machine, and the economies which may be effected by its use, may be gained from the accompanying illustrations, which show a few examples of work done on these machines in railroad shops. At the Concord shops of the Boston & Maine Railroad all rod brasses, rod keys, key guards and shims are finished on one of these machines with a considerable saving of time over the old method of planing. A cast iron frame has recently been rigged up for accurately milling the teeth in the reverse lever and throttle lever quadrants. The quadrant with radial arms at the ends makes a sector swinging on a fixed center, and this, by means of a stop pin and rack, is allowed a movement equal to the pitch of the tooth. The time for machining one of these quadrants is very much less with this arrangement than when the work was done on a shaper. On page 32 of our January journal several operations are cited, which were formerly done on slotting machines at the Havelock shops of the Burlington & Missouri River Railroad, but which are now done on a vertical milling machine at a greatly reduced cost.

A general view of one of these machines is shown in Fig. 1. Figs. 2 to 6 illustrate the various operations which cover the entire process of finishing a connecting rod brass at the Concord shops on a Becker-Brainerd miller without the use of special gang cutters. In the first operation, shown in Fig. 2, an inserted tooth face mill is used for facing the bottoms of the 5 brasses. The table is fed at the rate of 7 ins. per minute, and a very smooth and accurate finish is obtained. The work is so clamped that changes may readily be made to facilitate finishing the other surfaces. The second operation shown in Fig. 3 consists in finishing the inner sides of the lower flanges. An inserted tooth cutter is used, and the table is fed at the rate of 3½ ins. per minute. The upper flanges are finished at the same setting by changing the cutter, which requires but a moment. In finishing the sides of the brasses (Fig. 4) the same mill is used as in Fig. 2, but it is fed at a somewhat slower rate. But a short time is required to loosen the

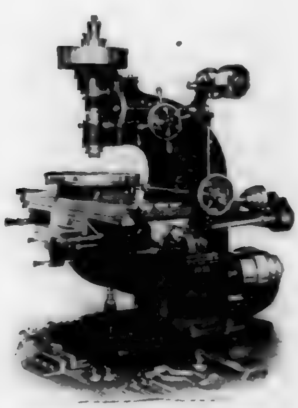


FIG. 1.

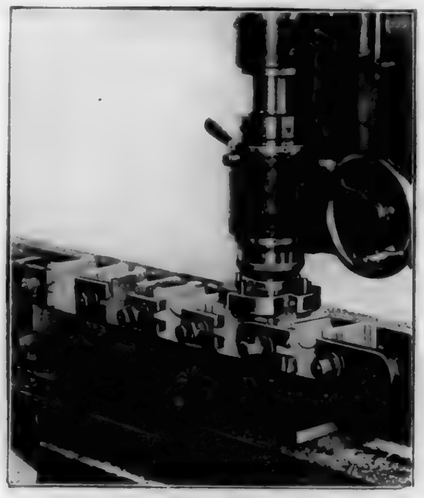


FIG. 2.

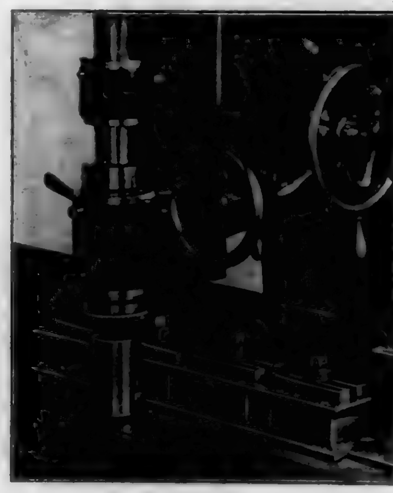


FIG. 3.

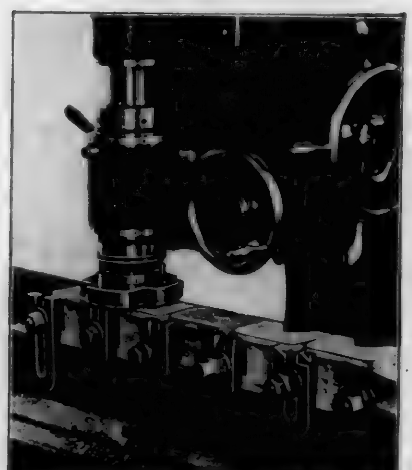


FIG. 4.

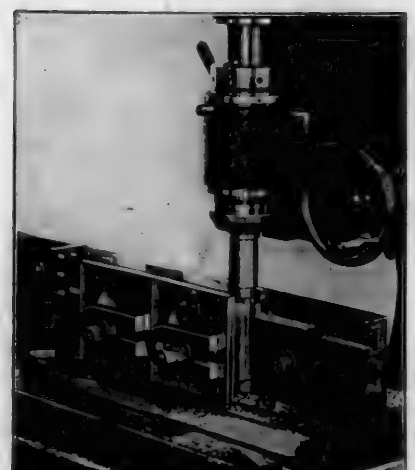


FIG. 5.

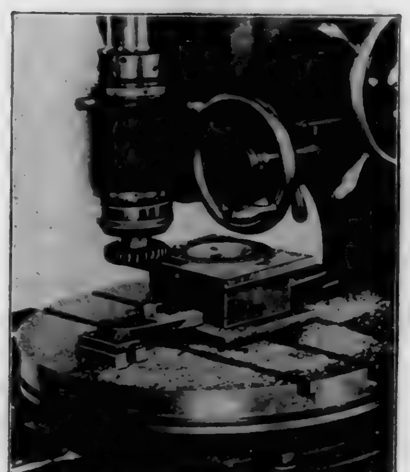


FIG. 6.

FINISHING A CONNECTING ROD BRASS ON A VERTICAL MILLING MACHINE AT THE CONCORD SHOPS.

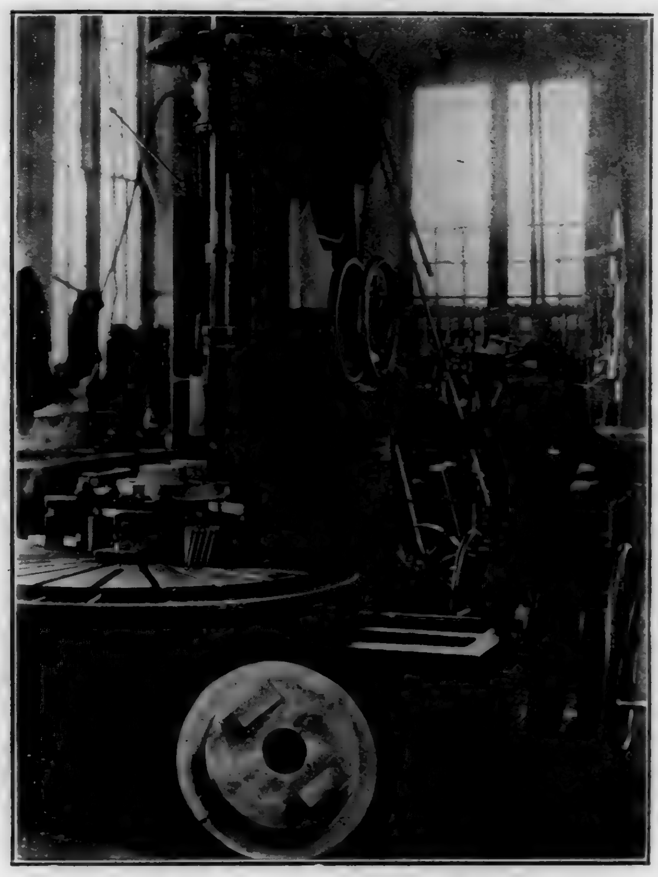


FIG. 7—MILLING BACK CYLINDER HEAD.

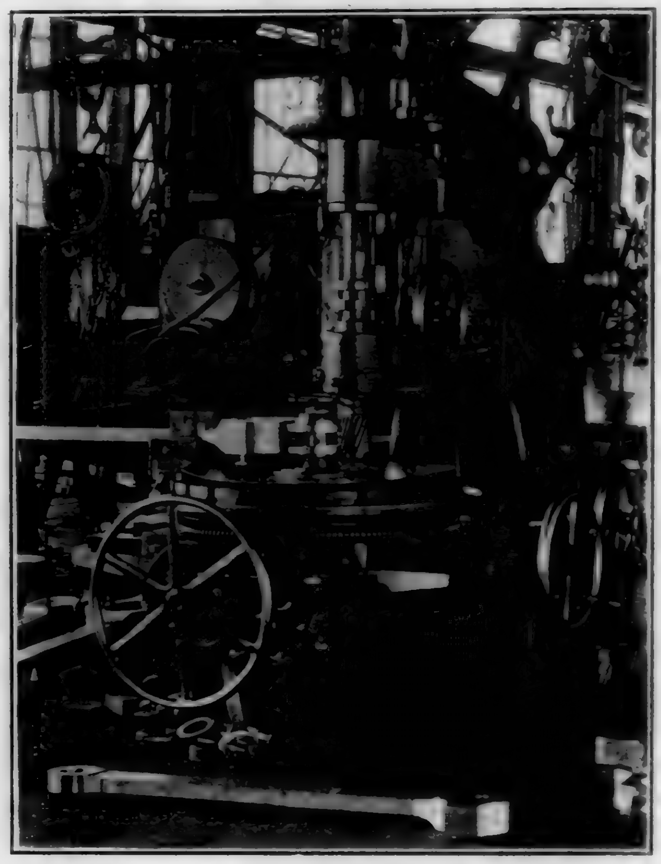


FIG. 8—MILLING SIDE ROD ENDS.

clamps, reverse them, reclamp them and finish the other side with the same tool. The bottom of the recess (Fig. 5) is finished with an inserted tooth cutter in 2 cuts per side, each at the rate of 14 ins. per minute. The tops of the flanges are finished in separate cuts at the same rate of feed. Fig. 6 illustrates the final operation by which the side of the box and the fillet are finished at the same operation by means of a round-nosed mill. For this purpose the rotary table is employed, and great accuracy of finish is obtained.

Fig. 7 shows a back cylinder head being finished on a Bement-Miles vertical milling machine in another shop. One of the finished cylinder heads is shown in the foreground. This work was formerly done on a planer, but because of the lugs to which the guides are bolted it was necessary to plane the piece in two directions. This gave a poor finish, and the time required was about five hours for the head of a 25-in. cylinder. On the vertical milling machine two cutters are used, one for finishing the horizontal surface and the bevel cutter for giving the required angles to the lugs. By this means the head for a 25-in. cylinder may be finished in 2½ hours, and with a very much better finish than formerly obtained. At the Schenectady works of the American Locomotive Company the ends of the side rods are finished on vertical milling machines. Fig. 8 shows a Niles-Bement-Pond machine rounding off the large end of a side rod. This work was formerly done on slotters at a much greater cost.

PERFORMANCE OF MALLET COMPOUND LOCOMOTIVE.

BALTIMORE & OHIO RAILROAD.

The Mallet articulated duplex compound locomotive, No. 2400, which is the largest locomotive that has been built, was completed about one year ago, and exhibited at the Louisiana Purchase Exposition at St. Louis. Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio, sends the following information concerning its performance:

After the closing of that exhibition the locomotive was brought to the Connellsville division of the Baltimore & Ohio Railroad, and put into regular service on January 6th, 1905, to assist heavy freight trains over the mountain. This locomotive has made several road trips and been in mountain helper service during the past four months, and in this time it has made about 13,500 miles.

The locomotive was designed for the purpose of balancing the power on the division, and to reduce the number of locomotives and crews required to handle heavy freight tonnage over the mountain districts. In order to develop a locomotive of exceptional tractive power to be used for this class of work on a mountain line having considerable curvature and heavy gradients, it was necessary to provide for the maximum adhesion distributed over a short rigid and long flexible wheel base.

The total weight, which is all carried on the driving wheels, which are 57 ins. in diameter, is 334,500 lbs. when the locomotive is in working order. Including the tender, which has a capacity of 15 tons of coal and 7,000 gals. of water, the total weight is 479,500 lbs., or about 193,500 lbs. less than the combined total weight of two of the heaviest consolidation locomotives that are used for through freight service over this same mountain district.

While the draw bar pull behind the tender of two of the consolidation locomotives is about 79,400 lbs., the draw bar pull of No. 2400 is about 74,000 when working compound, and 84,000 lbs. when working simple. The weight of train that can be taken up the mountain by two of the consolidation locomotives is about 2,025 tons contained in loaded steel cars of 100,000 lbs. capacity. The weight of train that No. 2400 and one of the consolidation locomotives can take up the grade is about 3,210 tons contained in similar cars. The above figures are based on the locomotives operating at a speed of ten miles per hour under fair coal and weather conditions, and with No. 2400 working in compound gear.

From the results of the practical performance during the past four months it has been demonstrated that the various special features which are combined in this design will give satisfactory results from an operating standpoint. The use of the articulated feature, as well as of the duplex compound system, with its intercepting valve and simpling gear devices,

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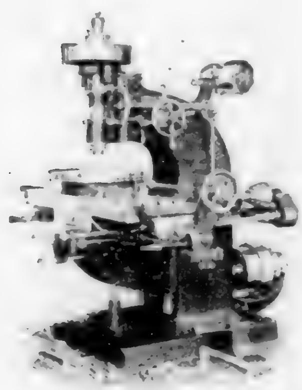


FIG. 1.

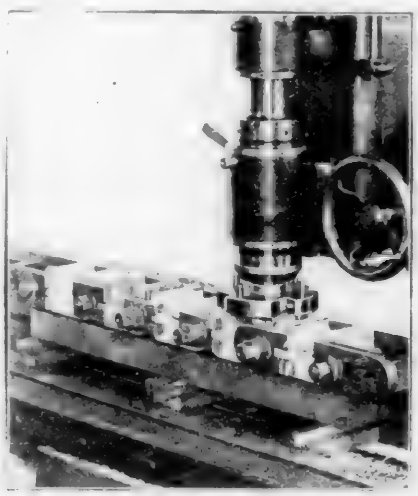


FIG. 2.

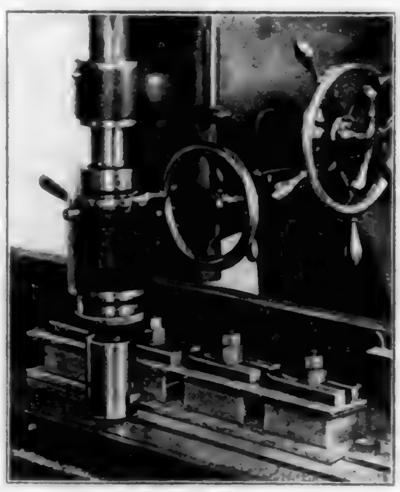


FIG. 3.

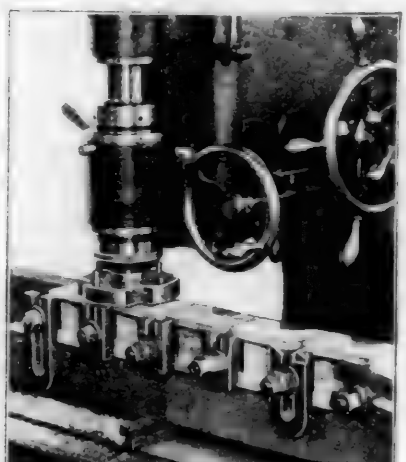


FIG. 4.

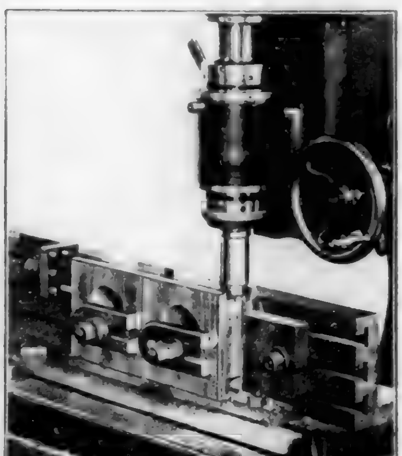


FIG. 5.

FIG. 6.

FINISHING A CONNECTING ROD BRASS ON A VERTICAL MILLING MACHINE AT THE CONCORD SHOPS.

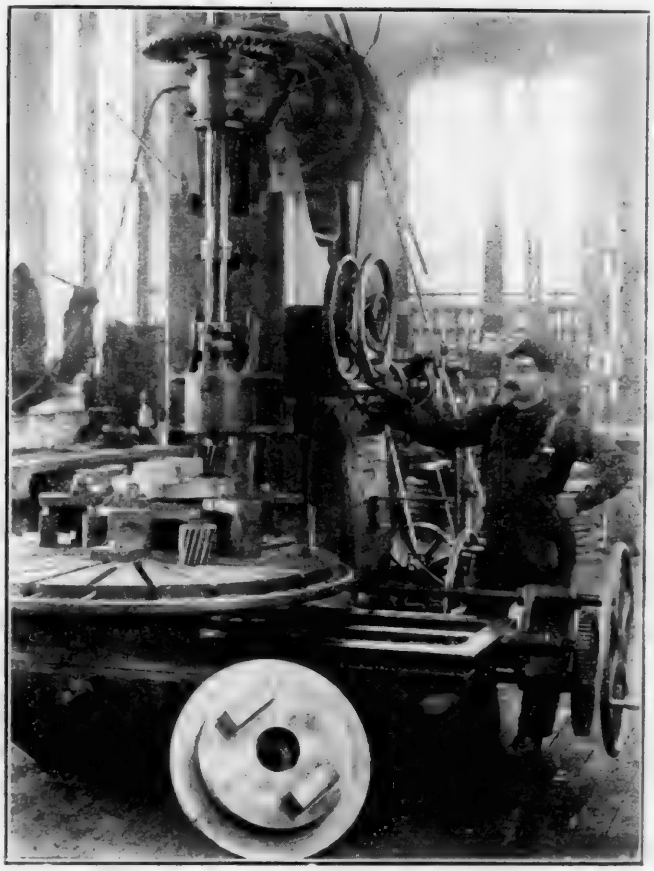


FIG. 7—MILLING BACK CYLINDER HEAD.

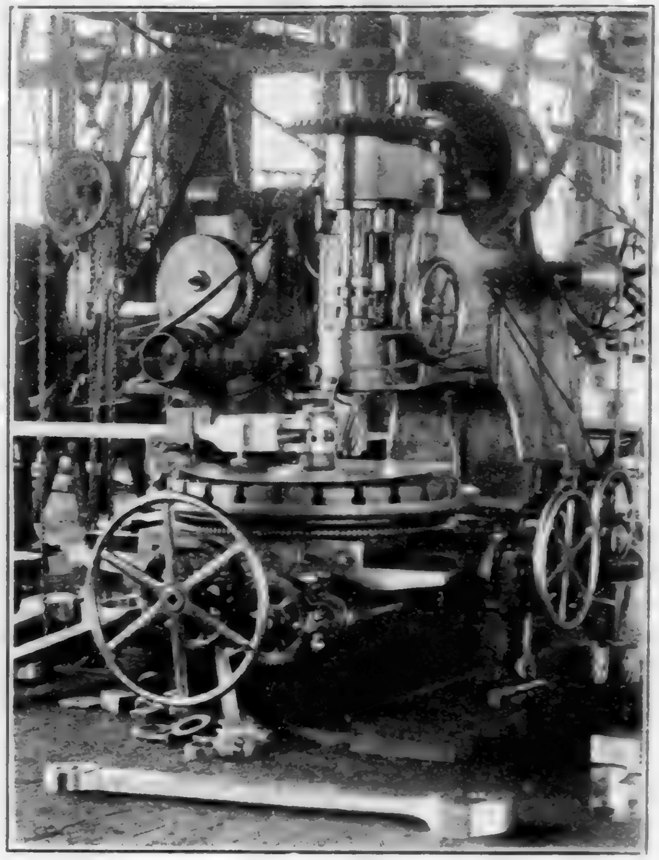


FIG. 8—MILLING SIDE ROD ENDS.

clamps, reverse them, reclamp them and finish the other side with the same tool. The bottom of the recess (Fig. 5) is finished with an inserted tooth cutter in 2 cuts per side, each at the rate of 14 ins. per minute. The tops of the flanges are finished in separate cuts at the same rate of feed. Fig. 6 illustrates the final operation by which the side of the box and the fillet are finished at the same operation by means of a round-nosed mill. For this purpose the rotary table is employed, and great accuracy of finish is obtained.

Fig. 7 shows a back cylinder head being finished on a Bement-Miles vertical milling machine in another shop. One of the finished cylinder heads is shown in the foreground. This work was formerly done on a planer, but because of the lugs to which the guides are bolted it was necessary to plane the piece in two directions. This gave a poor finish, and the time required was about five hours for the head of a 25-in. cylinder. On the vertical milling machine two cutters are used, one for finishing the horizontal surface and the bevel cutter for giving the required angles to the lugs. By this means the head for a 25-in. cylinder may be finished in 2½ hours, and with a very much better finish than formerly obtained. At the Schenectady works of the American Locomotive Company the ends of the side rods are finished on vertical milling machines. Fig. 8 shows a Niles-Bement-Pond machine rounding off the large end of a side rod. This work was formerly done on slotters at a much greater cost.

PERFORMANCE OF MALLET COMPOUND LOCOMOTIVE.

BALTIMORE & OHIO RAILROAD.

The Mallet articulated duplex compound locomotive, No. 2400, which is the largest locomotive that has been built, was completed about one year ago, and exhibited at the Louisiana Purchase Exposition at St. Louis. Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio, sends the following information concerning its performance:

After the closing of that exhibition the locomotive was brought to the Connellsville division of the Baltimore & Ohio Railroad, and put into regular service on January 6th, 1905, to assist heavy freight trains over the mountain. This locomotive has made several road trips and been in mountain helper service during the past four months, and in this time it has made about 13,500 miles.

The locomotive was designed for the purpose of balancing the power on the division, and to reduce the number of locomotives and crews required to handle heavy freight tonnage over the mountain districts. In order to develop a locomotive of exceptional tractive power to be used for this class of work on a mountain line having considerable curvature and heavy gradients, it was necessary to provide for the maximum adhesion distributed over a short rigid and long flexible wheel base.

The total weight, which is all carried on the driving wheels, which are 57 ins. in diameter, is 334,500 lbs. when the locomotive is in working order. Including the tender, which has a capacity of 15 tons of coal and 7,000 gals. of water, the total weight is 479,500 lbs., or about 193,500 lbs. less than the combined total weight of two of the heaviest consolidation locomotives that are used for through freight service over this same mountain district.

While the draw bar pull behind the tender of two of the consolidation locomotives is about 79,400 lbs., the draw bar pull of No. 2400 is about 74,000 when working compound, and 84,000 lbs. when working simple. The weight of train that can be taken up the mountain by two of the consolidation locomotives is about 2,025 tons contained in loaded steel cars of 100,000 lbs. capacity. The weight of train that No. 2400 and one of the consolidation locomotives can take up the grade is about 3,210 tons contained in similar cars. The above figures are based on the locomotives operating at a speed of ten miles per hour under fair coal and weather conditions, and with No. 2400 working in compound gear.

From the results of the practical performance during the past four months it has been demonstrated that the various special features which are combined in this design will give satisfactory results from an operating standpoint. The use of the articulated feature, as well as of the duplex compound system, with its intercepting valve and simpling gear devices,

Walschaert valve gear, combination hand and power reversing gear, and flexible intermediate receiver and exhaust pipes, have resulted in no embarrassment whatever. The curving and tracking qualities, when the locomotive is going ahead or backing up, have been satisfactory, and there has been very little flange wear, a.though all driving wheels are equipped with flanged tires. The steaming capacity of the boiler, working of all frictional parts, cylinder packing, piston and slide valves, and the other features that go to make up the requirements for maximum hauling capacity, have been very satisfactory.

While the 2¼-in. tubes in the boiler of this locomotive are 21 ft. in length, practically no difficulty has been experienced due to choking, or on acount of tube, firebox or staybolt leakage. Furthermore, there has been no trouble on acount of priming or lubrication. While it has been noted that quite a number of changes in the minor deails would be desirable, should other locomotives of this type be constructed, still, when taken as a whole, the design, construction and operation can be considered as satisfactory. With respect to the maintenance, this is an item that remains for the future performance to determine, but from present indications, the cost per ton mile will be no greater than that for ordinary consolidation types of helper locomotives.

When operating over combination level and mountain divisions, No. 2400 will consume less coal per ton mile than the various types of simple consolidation locomotives now in the service, and when operated on comparatively level lines, it consumes materially less coal per ton mile. On the mountainous part of the division, the fuel consumption per ton mile is more favorable than for the simple consolidation locomotives, but not to such a great extent as when working on the more level portions of the division.

In averaging up the performance of several through freight trips made during the month of January, 1905, over the division between Connellsville and Rockwood and Connellsville and Sand Patch, these through freight runs being from 44 to 60 miles in length, the following data were recorded:

Running time	5 hrs. 29 mins.
Time lost by stops	3 hrs. 38 mins.
Total time of trip	9 hrs. 7 mins.
Speed while running, miles per hour	9.7
Temperature of atmosphere	33 deg. F.
Temperature of feed water	33 deg. F.
Kind of coal used	Bituminous, about 40 per cent. volatile, run-of-mine grade
Pounds of coal used per trip	24,900
Pounds of coal consumed per sq. ft. of grate area per hour	61.8
Pounds of coal consumed per mile run	472
Pounds of coal consumed per 1,000-ton miles	215
Number of loaded cars hauled	34
Number of empty cars hauled	None
Gross tonnage per train (in tons of 2,000 lbs.)	2,193
Maximum boiler pressure	230 lbs.
Minimum boiler pressure	202 lbs.
Average boiler pressure	220 lbs.
Pounds of water evaporated per lb. of coal	6.4
Pounds of water evaporated per lb. of coal from and at 212 deg. F.	7.9
Minimum gradient on line	level
Maximum gradient on line	1 per cent.
Average gradient on line	.5 per cent.

On the 1 per cent. grade, which is 6½ miles in length, No. 2400 was assisted by one of the regular consolidation type locomotives. On all other portions of the line, where the gradients range from 1 per cent. for a distance of 1 mile, .75 per cent. for a distance of 5 miles, .68 per cent. for a distance of 2 miles, and other grades average from .3 per cent. to .5 per cent., No. 2400 handled the train alone.

The performance of this locomotive for 24 consecutive trips helping trains and operating over a total distance of 14.8 miles up the mountain, the first 8.3 miles of gradient ranging from .2 per cent. to .5 per cent, and the remaining 6.5 miles being 1 per cent., averaged as follows:

Running time	1 hr. 45 mins.
Time lost by stops	2 hrs. 16 mins.
Total time of trip	4 hrs. 1 min.
Speed while running, miles per hour	9.1
Temperature of atmosphere	17 deg. F.
Temperature of feed water	33 deg. F.
Kind of coal used	Bituminous, about 20 per cent. volatile, run-of-mine grade.
Lbs. of coal consumed per trip	8,225
Lbs. of coal consumed per sq. ft. of grate area per hour	66
Lbs. of coal consumed per 1,000-ton miles	303.5
Number of loaded cars per train	39
Number of empty cars per train	None
Gross tonnage per train (in tons of 2,000 lbs.)	2,049
Maximum boiler pressure	230 lbs.
Minimum boiler pressure	188 lbs.
Average boiler pressure	218 lbs.
Lbs. of water evaporated per lb. of coal	5.4
Lbs. of water evaporated from and at 212 deg. F. per lb. of coal	6 7
Total amount of water used while running	39,142 lbs.
Total amount of water used during stops	6,652 lbs.
Total amount of water used during trip	45,794 lbs.
Per cent. of total amount of water used while locomotive was standing	14.5 per cent.

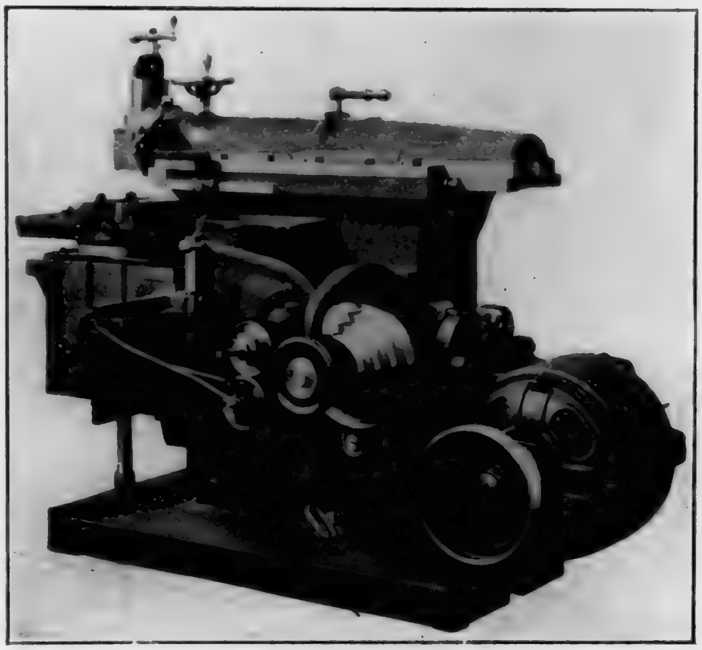
One engineer and one fireman were used on all of these tests to operate the locomotive during each trip. During these tests there were no firebox, boiler tube, or other water or steam leaks around the boiler or machinery of the locomotive, and the waste was that relieved through the pop valves, from injector overflow, on account of condensation, using heaters on injectors, and other similar causes resulting during winter weather and freezing conditions. There were no failures or delays on account of locomotive, except for fire cleaning, and which work was performed at the termination of the run.

In mountain helper service locomotives are frequently required to remain at work for extraordinary periods between fire cleanings, and during such intervals with the forcing of fires to the maximum, doing short service and pushing trains up to grade, together with drifting down grade, and long time between trips, there is considerable opportunity for variation in the temperature in the firebox and flues, which would tend to cause leakage and failure. Under such conditions, however, No. 2400 has been able to meet the requirements, and at the same time make use of an ordinary grade of run-of-mine bituminous coal, and maintain ample boiler pressure at all times to handle the work.

It may be added that the greatest curvature on the line over which No. 2400 operates is about 9 deg., while on the heaviest grade there is a reverse curvature of about 7 deg.

MOTOR-DRIVEN CRANK SHAPER.

The accompanying photograph illustrates an interesting motor application to a Cincinnati 24-in. back geared crank shaper. The casting to which the motor is attached is hinged at its lower end, while the upper end may be adjusted for the purpose of tightening the belt by means of the cap and set screw. The motor shown is a Jantz & Leist 110-volt constant speed 5-h.p. This shaper is on exhibition at the Liege Exposition in Belgium and is equipped with a motor of foreign



CINCINNATI MOTOR-DRIVEN CRANK SHAPER.

make, the one shown in the photograph being put on for test purposes before the machine was shipped. This accounts for the fact that it does not exactly fit the pads on the tilting leaf. The back gears are controlled by the rod shown near the base of the machine just below the cone pulley. The gear protected by the casing just above this rod is keyed on the driving shaft or shaft which carries the cone pulley on the standard belt

driven machine. This is driven by a small pinion on the shaft above, which in this case carries the cone pulley. The ram may be adjusted by hand by means of the small wooden hand wheel on the end of the pulley shaft; the curved handle at the side of the machine operates a brake on the inside of the pulley.

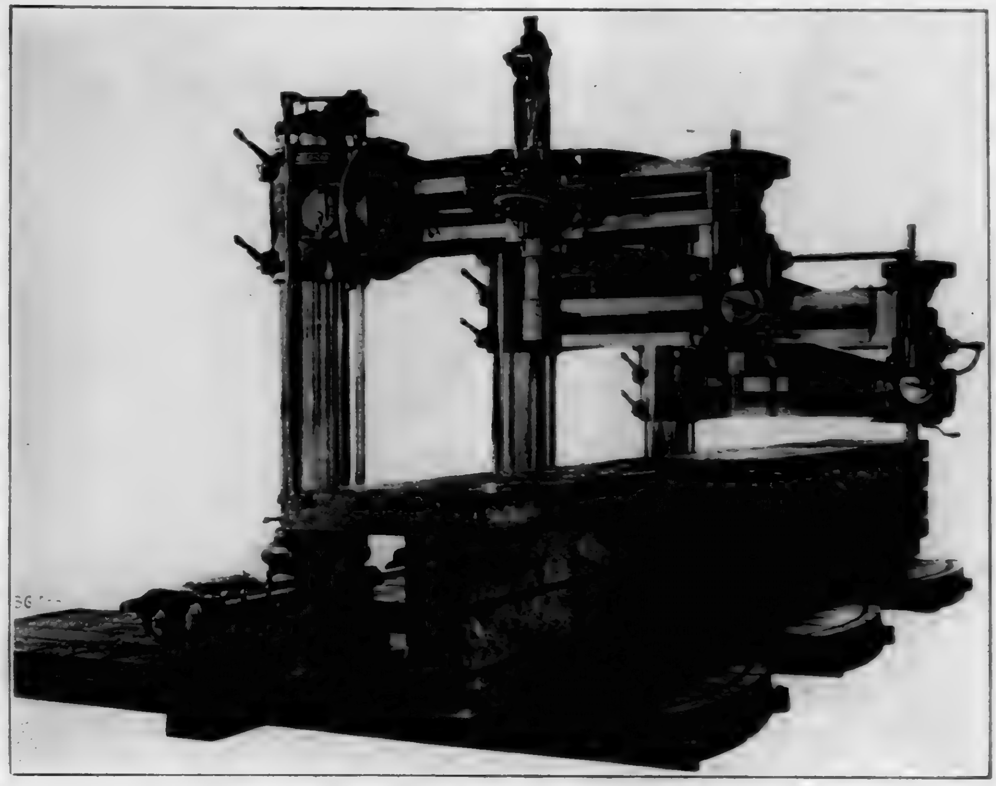
The machine is equipped with very powerful gearing and the design throughout is such that the work can be very accurately turned out under the most severe conditions of cutting. The column, which is very wide and deep, is ribbed and braced internally; horns project at the front and rear, thus affording an unusually long bearing for the ram. The length of the stroke may be changed while the machine is at rest or in motion. The cross transverse screw for the rail is provided with a graduated collar reading to .001 of an inch and with a variable automatic feed which may be changed from nothing to full speed while the machine is in motion. The head swivels to any angle and is graduated. The cross feed connecting rod is automatically adjustable to any height of the rail and does not depend upon frictional contact. The rail is raised and lowered by means of a telescopic screw which works on ball bearings. The outer support for the table is rendered very efficient by making the base stiff enough to rigidly withstand the thrusts which come upon it and care is taken to have the surface upon which the support slides made truly parallel with the travel of the table. The vise is of the double screw form and has a graduated swiveling base. An opening through the column under the ram provides for the keyseating of shafting and similar work up to 4 ins. in diameter. This machine weighs about 4,000 lbs., and is made by the Cincinnati Shaper Company.

LOCOMOTIVE FRAME DRILLING MACHINE.

The Louisville & Nashville Railroad has just installed in the new shops at Louisville a combination radial and locomotive frame drilling machine which consists of three 6-ft. radial drills, two plain and one full universal, each with a double base and one long T slotted table extending across them. It is designed with a view to working the high speed drills, taps and reamers to the limit of their efficiency. Each drill is a complete unit in itself and may be used either for work on locomotive frames clamped to the long table or the arm may be swung around to do the regular radial work on the opposite end of the base or on a box table which is furnished but not shown. Sufficient room is allowed between the columns so that each arm may be swung in a complete circle.

The three drills are driven by one direct current electric motor through the medium of a four-speed box on the base of each, which may be operated by the two levers while the machine is running. The speed boxes are connected to the drills by means of spur gearing, thus obviating all end thrust. The three drills are connected by couplings, the shaft which connects to the motor passing through the lower part of the stump or inner column in which it has its bearing. The inner columns extend to the top of the columns, and rigidly support them. The back gears are on the heads and deliver the power direct to the spindle and are easily controlled by levers conveniently placed for the operator. When the operator is tapping with the back gears in he can thus instantly change to a higher speed for backing out without changing his position or stopping the machine. The spindle may be started, stopped or reversed by a lever on the head, convenient to the operator, which obviates the necessity of stopping any of the running parts except the spindle. The tapping mechanism is controlled by the same lever and is carried on the back of the head between the back gears and the speed box, thus giving to the powerful friction the benefit of a high back gear ratio which makes possible unusually heavy tapping operations.

The plain radials have eight positive feeds ranging in geometrical progression from .007 to .063 ins., each instantly and easily obtainable through two dials on the head which clearly



AMERICAN LOCOMOTIVE FRAME DRILLING MACHINE.

show the various feeds. The power feed is delivered from the worm wheel to the spindles through a powerful friction controlled by a handle used for quick advance or return. The full universal radial has four positive feeds ranging from .007 to .045 ins., any one of which may easily be obtained by moving a knob to a given notch. Depth gauges and automatic stops are provided and the spindle is graduated. The spindle is also provided with a safety stop which prevents it from feeding beyond the limit. All the gears are protected by casings. This machine is made by the American Tool Works, Cincinnati, O.

HIGH-SPEED TWIST DRILLS.

While high speed drills have been in use long enough to demonstrate their great superiority over the carbon drills and are fast replacing them it is difficult to obtain definite information as to the average working speeds and feeds at which it is desirable to use them on different classes of materials. Because of the large number of varieties of iron and steel it is, of course, impossible to fix feeds and speeds suitable for all, and it is necessary for each user to determine this for himself, at least to a large extent. It is possible, however, to assist him by laying down a schedule of feeds and speeds which have been successfully used in general work and will at least establish a starting point in his investigations. In many cases it will be found impossible to work anywhere near the safe limit of these drills because the larger number of drill presses now in service are not powerful enough or have not a sufficient range of speeds, and it is therefore necessary

to adopt such speeds and feeds as are suitable to the machines. The revolution in the design of drilling machines caused by the use of high speed drills was commented upon on page 182 of our May issue.

The general statement has been made that these drills will run at about twice the speed and feed of the ordinary carbon steel drills, but an investigation seems to show that, while this is approximately true concerning the feeds, the speeds may be increased to considerably more than double those used with carbon steel. The following tables show the working speeds and feeds as recommended by the makers of two well-known high speed steels for use on mild steel, wrought iron and soft cast iron:

WORKING SPEEDS AND FEEDS FOR HIGH SPEED TWIST DRILLS.

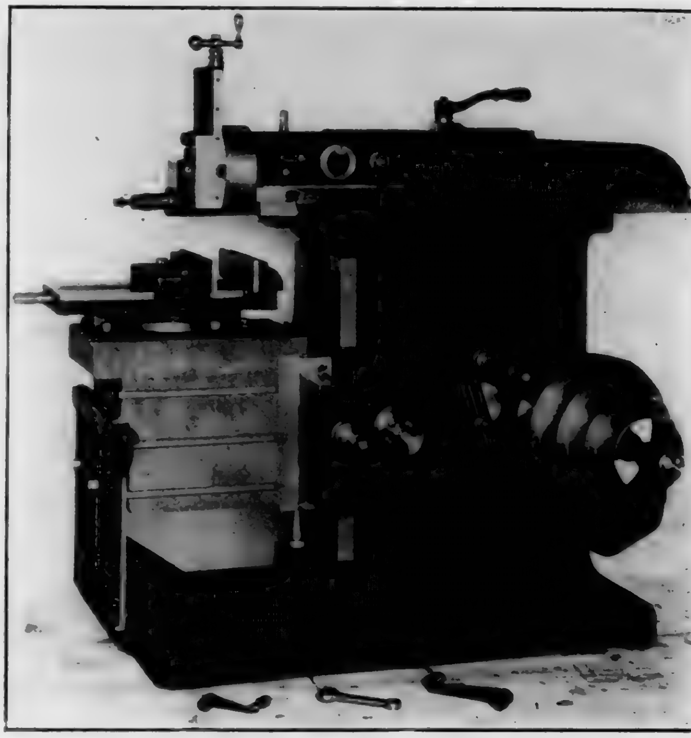
Diameter of Drill. ins.	A		B	
	Speed, R. P. M.	Approx. Feed Per Rev.	Speed, R. P. M.	Approx. Feed Per Rev.
¼	980	.008	1,050	.008
5-16	785	.008	850	.008
⅜	625	.01	700	.011
7-16	600	.01	600	.011
½	585	.01	525	.016
⅝	470	.013	425	.016
¾	365	.013	350	.016
⅞	300	.013	300	.016
1	260	.015	260	.020
1⅛	220	.015	230	.020
1¼	200	.015	215	.020
1⅜	165	.015	200	.020
1½	150	.015	180	.020
1¾	110	.015	150	.020
2	105	.017	130	.020
2¼	100	.017	120	.020
2½	96	.017	105	.020
2¾	92	.017	100	.020
3	80	.017	90	.020
3¼	75	.017	...	...
3½	68	.017	...	...
3¾	64	.017	...	...
4	60	.017	...	...

These are the average working speeds and are considerably lower than speeds and feeds which are being successfully used in very many cases. The makers' names are withheld, as it is quite possible that one of them may have been more conservative in his estimates, and it might lead to drawing an unfair inference concerning the comparative value of the two steels. In both cases successful tests were described of high speed drilling at much higher rates than those recommended for general use, in fact, the maker of the steel A states that they are able to drill through cast iron at the rate of 24 ins. per minute and through mild steel at the rate of 12½ ins. per minute. The maker of steel B advises that in nine cases out of ten it will be possible to run the drills at 25 per cent. higher speeds on cast iron than shown in the table, and that on brass the speeds may be doubled, and in all cases the drills should be run dry. With steel A a lubricant should be used for mild steel, but not for cast iron.

20-INCH CRANK SHAPER.

The accompanying photograph illustrates a newly designed 20-in. Stockbridge crank shaper which has several noteworthy features. The automatic feeds to both the head and table are adjustable while the machine is in motion. The outer table support supports it for its entire width; the table is raised sufficiently above the saddle to allow the T bolts to be put in from the back as well as from the front; the table hooks over the saddle, thus making it more rigid than when the bolts alone are used. The driving gear is 20 in. in diameter and has a 3½-in. face, and this, together with back gears and the 4-step cone driven by a 3-in. belt, makes a very powerful machine. It is equipped with the Stockbridge 2-piece crank motion, which furnishes a powerful and even cutting speed for the entire length of the cutting stroke and gives a very quick return. The crank and gear are so constructed that the shaper has the same rigidity on the long stroke as on a short one, the cut on the 20-in. stroke being as free from chatter as on the 5-in. stroke.

The column is extended at both the front and back at the top, thus giving a long bearing for the ram. The swivel for the head is accurately graduated and may be set at any angle and is clamped in position by two bolts which hold it rigidly. The slide has a travel of 9 in. and is fitted with an automatic



STOCKBRIDGE 20-IN. CRANK SHAPER.

feed. The table has a working surface at the top of 14 by 20 ins. The stroke may readily be changed from the front of the machine. The table has a cross feed of 26 ins. and is automatic in either direction. It has a vertical movement of 13 ins. by means of the bevel gears and a telescopic screw, which is provided with ball bearings. The rocker arm and column are so constructed that a shaft as large as 4 ins. in diameter may be passed under the ram for keyseating. The vise has a swivel base which is graduated and may be set at any angle. The jaws are 3 by 12 ins. and open 12 ins. The finished machine and counter shaft weigh about 3,200 lbs. It is made by the Stockbridge Machine Company, Worcester, Mass.

BALANCING BALANCED COMPOUND LOCOMOTIVES.

METHOD OF COUNTERBALANCING REVOLVING PARTS ON A CRANK-AXLE.

In the balanced compound locomotive only the revolving weights are considered as the reciprocating parts move to and fro, balancing each other, and have no effect on the rail. The method employed by the Baldwin Locomotive Works in determining the position and weight of each counterbalance is as follows:

The revolving weights are concentrated at two points on each side of the engine; that is, at the centers of gravities of the outside pins and of the inside crank pins. These weights are made up (Fig. 1) as follows:

(a) Weights concentrated at each inside crank pin, composed of two crank cheeks, inside crank pin, back end of main rod. These weights will be known as W_a.

(b) Weights concentrated at each outside pin, composed of wrist pin, wrist pin hub, front end of side rod and, if so coupled, the back end of the main road. These weights will be known as W_b.

The throw of the weights W_a is balanced by two weights, one in each wheel, throwing in the opposite direction to the crank weights, and of such magnitude that the three parallel forces thus produced shall balance each other, any one being, therefore, equal and directly opposed to the resultant of the other two. The throw of the weights W_b is balanced by a weight in the wheel on the same side throwing in the opposite direction and by one in the opposite wheel throwing in the same direction, the respective weights being of such magni-

tude that the system of parallel forces so produced shall balance each other.

From the above it will be seen that in the left wheel the counterweights which balance the revolving weights of the right side are at 90 deg. to those which balance the revolving weights of the left side of the engine. In each wheel there will, therefore, be two counterweights, one opposite the inside crank and one at right angles. These two weights can be combined by either graphical or analytical methods.

In Fig. 2 let W_a = weights of inside crank pin.
W_b = weights at outside crank pin.
a_1 and a_2 = distance of centers of gravities of counterbalances from W_a.
b_1 and b_2 = distance of centers of gravities of counterbalances from W_b.
The weights C required in left wheel (Fig. 3) to balance W_a

$$C_1 \times (a_1 + a_2) = W_a \, a_2$$

$$C_1 = \frac{W_a \, a_2}{a_1 + a_2}$$

the weight C_2 in the right wheel being

$$C_2 = \frac{W_a \, a_1}{a_1 + a_2}$$

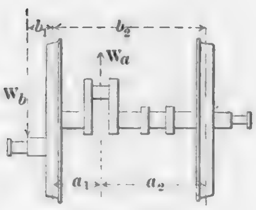


FIG. 1

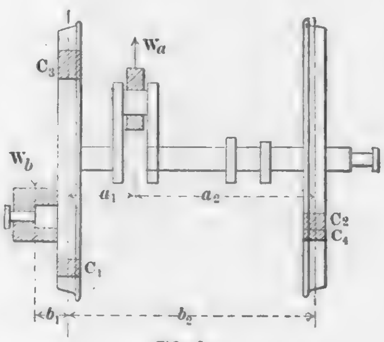


FIG. 2

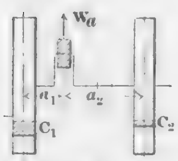


FIG. 3

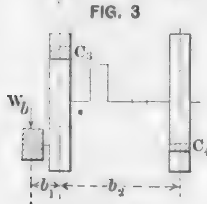


FIG. 4

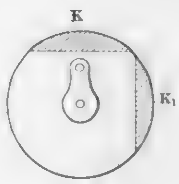


FIG. 5

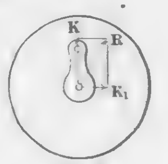


FIG. 6

FIG. 7

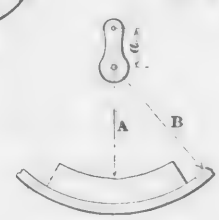


FIG. 8

These two weights throw in the opposite direction to W_a. The weight C_3 required in the left wheel (Fig. 4) to balance outside weights W_b.

$$C_3 \, b_2 = W_b \; (b_1 + b_2)$$

$$C_3 = \frac{W_b \; (b_1 + b_2)}{b_2}$$

This weight is opposite to the pin. The required weight C_4 in the right wheel being

$$C_4 \times b_2 = W_b \; b_1$$

$$C_4 = \frac{W_b \; b_1}{b_2}$$

This weight throws in the same direction as the weights W_b.

Since W_a and W_b are 180 deg. apart, the counterweights to balance them in the left wheel will likewise be opposed to each other, the actual weight to use will therefore be

$$K = C_3 - C_1.$$

The weights in the left wheel which balance the revolving weights on the right side both throw in the same direction and at 90 deg. from the weights just determined, therefore, a second weight (Fig. 5)

$$K_1 = C_2 + C_4$$

must be placed 90 deg. from the above.

These weights can be combined either analytically or graphically, and both their magnitude and direction determined by the usual method of scaling two lines at right angles to each other, their length being proportionate to the counterweights completing the parallelogram, the diagonal of which will give both the size of the resultant weight and the angle at which it should be placed.

It can also be determined analytically (Fig. 6):

$$R = \sqrt{K^2 \; K_1^2}$$

and $\frac{K}{K_1}$ = tangent of the angle.

To this point the weights can be considered as acting at a radius equal to the crank arm. The weight at the rim of the wheel can be calculated irrespective of the diameter of the wheel (Fig. 7).

$$\text{Chord A B} = \sqrt[3]{\frac{12 \; R \; a}{t \;\; q}}$$

R = Known weight at crank pin radius a.
t = Thickness of counterbalance.
q = Weight of cu. in. of metal.

In applying the formula the thickness should be assumed. The sector balance (Fig. 8) can be calculated as follows:

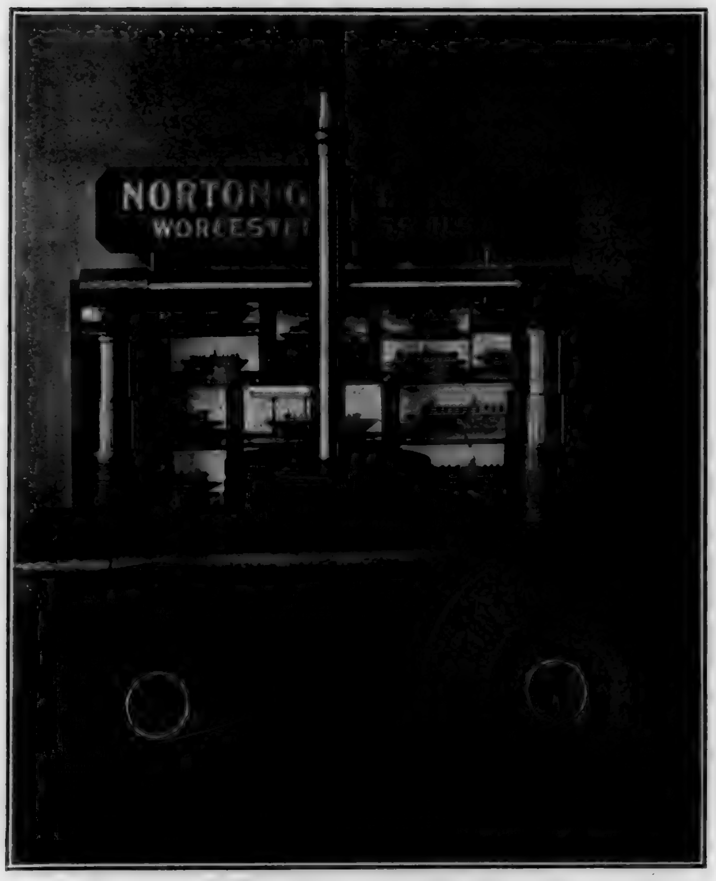
$$A = \sqrt[3]{B^3 - \frac{3 \; R \; a}{2 \; t \; q \; \sin \frac{180 \; M}{n}}}$$

B = Outside radius.
A = Inside radius.
n = Number of spokes.
M = Spaces to be filled by balance.

GRINDING IN LOCOMOTIVE REPAIR SHOPS.

In connection with an article on grinding processes for locomotive repair work in the Collinwood shops of the L. S. & M. S. Ry., on page 145 of our April, 1903, journal, the Norton 18 by 96-in. plain grinding machine was described, and the accuracy and rapidity with which crank pins, piston rods and valve stems were finished was commented upon. The accompanying photograph shows several samples of work done on one of these machines which were exhibited at the Railway Appliance Exhibition in connection with the International Railway Congress. The piston and rod in the center were in service on the Lake Shore for some time, and the rod was repaired by grinding without re-turning. The ring shown near the top is made in two halves, with solid joints, and was very carefully fitted to the rod. The rod is ground so straight and true that with the ring fitted to move freely no variation in friction can be detected. This is a very severe test, for a variation of .0001 in. may be easily detected with a ring fitted as carefully as this one was.

We are told that an operator at the Collinwood shops ground a pair of these rods with the pistons on in 30 minutes, taking them from the floor, finishing them and replacing them on the floor in that time. On some parts of the rods, owing to the sprung condition, it was necessary to reduce the diameter as much as 1-32 in. The average time, however, required for grinding such rods with an ordinary operator is about 30 minutes each. A new rod if properly or cheaply turned requires about the same time for grinding as an old one does. If turned with the same finish as required for filing, a good operator does not require more than five minutes to finish the rod by grinding. It is, however, more profitable to give it a rougher finish and remove a larger amount of metal by grinding.

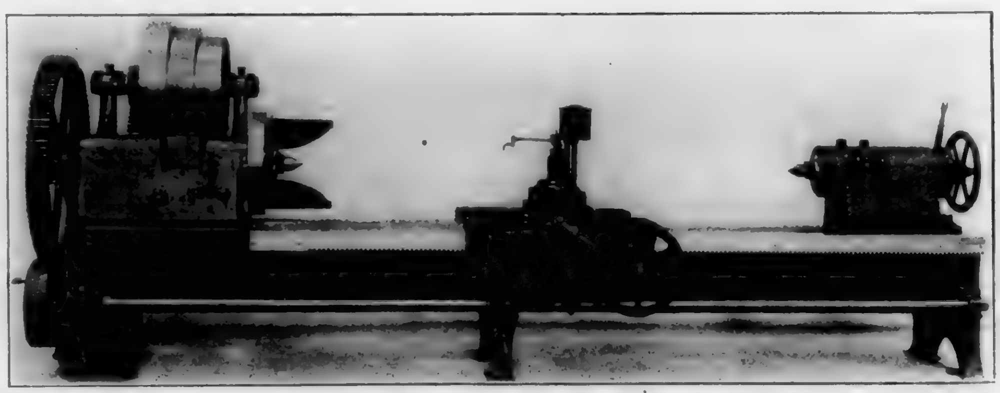


EXAMPLES OF GRINDING IN LOCOMOTIVE REPAIR SHOPS.

The time required for grinding crank pins, such as shown in the photograph, is about 15 minutes each if they are cheaply turned with a coarse finish, as shown on the unfinished portion. The new piston rod resting on top of the crank pins and with the ends left blank was ground accurately to .00025-in. limits for roundness and straightness. The wheels standing in the front of the table are the ones used for grinding this work; the one on the right has a 4-in. face, and is used for grinding piston rods, while the one at the left has a 2-in. face and is used for grinding crank pins and valve stems. The machine upon which this work is done is arranged so that the valve stem yoke and the piston swing in the same gap. It was designed specially for locomotive work, and is one of several different types of grinding machines made by the Norton Grinding Company, of Worcester, Mass.

HEAVY TURNING LATHE.

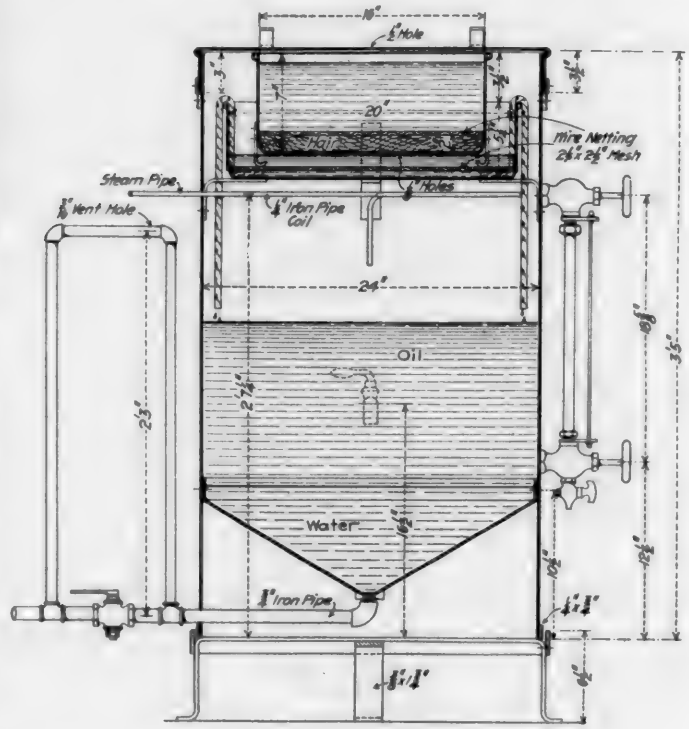
The heavy Sellers' lathe shown in the photograph is intended for turning locomotive axles and similar work, and swings 25 ins. diameter over the bed and 13½ ins. over the carriage. It is especially adapted for the use of the high-speed steels, and is designed to overcome a force of 20,000 lbs. at the tool when turning a 10-in shaft, 25,000 on an 8-in diameter and 33,000 on a 6-in. diameter. The tool carriage is very heavy, the spindles in both the head and tailstocks are large in diameter and have steel centers. The bed is flat on top, with vertical guiding surfaces. The tailstock spindle is clamped in two places, and centered by a patent double cone grip. The tailstock is held with six bolts, and has a patent under V guide. Positive geared feeds are provided, and the feed rack is steel with cut teeth. The face plate is provided with a Clement's double driver. The lubricant for the cutting tool is forced through a circulating system of pipes by means of a power pump. This lathe is made by William Sellers & Co., Inc., Philadelphia, Pa.



SELLERS HEAVY LATHE FOR LOCOMOTIVE AXLES.

OIL FILTER.

The accompanying illustration shows an oil filter for the waste oil from stationary engines which is simple in construction and operation, and has given very satisfactory results at the Depew shops of the New York Central. The oil is emptied into the small upper tank, and filters down through the wire netting and hair felt into a second tank, and is siphoned by the candle wicking from this into the large tank. The ¼-in. steam pipe coil is used to warm the oil to about 125 deg., so that it will flow freely. As the steam from this condenses the water settles to the bottom of the tank and is drained off by means of the valve in the ¾-in. pipe. The inverted U in the ¾-in. pipe allows the water to drain off if the level in the tank becomes too high. The oil is removed from the large tank by the valve at the side. We are indebted to Mr. J. F. Deems, general superintendent of motive power of the New York Central Lines, for this information.



OIL FILTER—DEPEW SHOPS.

Thirty-six and nine-tenths per cent. of the world's production of coal, or 319.1 million tons, were produced in the United States in 1903.

PRODUCTION IMPROVEMENTS.

PACKING RINGS FOR PISTONS.—One hundred and twenty-two packing rings in 10 hours is the record of a 42-in. Bullard standard boring mill, as shown at the Railway Appliance Exposition held last month at Washington. At the Bullard exhibit the following facts are shown from a record made at the West Albany shops of the New York Central & Hudson River Railroad.

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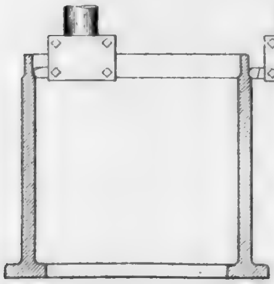
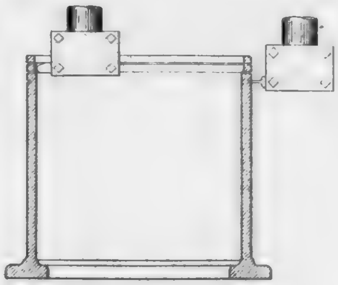


FIRST OPERATION.



THIRD OPERATION.

take a ⅛ in. finishing feed on the outside. The record of 10 hours' work is given in the following table:

Castings.	Diameter.	Rings.	Diameter.	Hours.	Minutes.
1	19½ ins.	13	18½ ins.	1	5
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1	20 ins.	13	19 ins.	1	5
1	20 ins.	13	19 ins.	1	5
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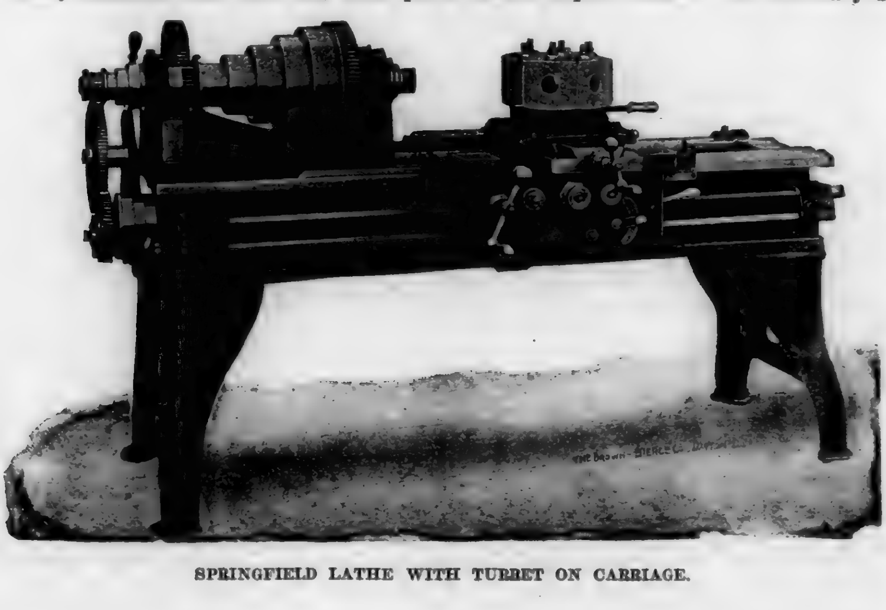
9 Castings.		122 Rings.		9 Hrs.	60 Min.

This record attracted a great deal of attention, as well it may. The machine is heavy, convenient to handle, and such work is rendered possible in any railroad shop. Further information may be had from the Bullard Machine Tool Company, Bridgeport, Conn.

LATHE WITH TURRET ON THE CARRIAGE.

The photograph shows an 18-in. standard Springfield lathe equipped with a friction geared head and a turret on the carriage in place of the regular compound rest. This lathe has been made to meet the demand from railroad shops and automobile builders for a machine which could rapidly and accurately machine cast iron and steel parts which require more than one operation, and serve the purpose of a heavy turret lathe.



SPRINGFIELD LATHE WITH TURRET ON CARRIAGE.

While the friction geared head adds to the cost of the machine, it is very desirable on a standard engine lathe, and is indispensable on screw machines and turret lathes. The frictions are carefully constructed, with convenient means of adjusting for wear, and will last as long as the machine itself.

The carriage, which is very heavy and is gibbed to the outside of the bed at both front and back, is fitted with a turret slide 10 ins. in width and 16 ins. in length upon which the turret revolves. The turret is hexagonal in form, 10½ ins. wide across flats, and the holes are 2 ins. in diameter. Provision is also made for bolting special cutters to the faces of the turret. The index pin and clamping lever are at the right side of the turret in a convenient position for the operator, but entirely out of the way. The lathe is provided with a power cross feed, a longitudinal feed and a screw cutting apparatus, and, if desired, may be equipped with a taper attachment. It weighs about 2,400 lbs., and is made by the Springfield Machine Tool Company, of Springfield, Ohio.

VICTOR AUTOMATIC LOCOMOTIVE STOKER.

The automatic stoker as applied to locomotives has demonstrated its capability for feeding and satisfactorily spreading more coal than can possibly be handled by any fireman. It has handled as much as 18,000 lbs. per hour, spread over a surface of 8 ft wide by 9 ft. long, thus demonstrating its capacity to be more than equal to the greatest demands of locomotive service. The Victor stoker, formerly known as the Day-Kincaid, was exhibited at Washington during the convention of the International Railway Congress, being shown in operation, using chestnut anthracite because of its cleanliness, although it is generally used with bituminous coal. Because of the fact that this stoker will handle slack coal as efficiently as run-of-mine, it affords an opportunity for a saving in operating cost, entirely independent of the economy of mechanical stoking. Extensive road tests have indicated the possibility of saving from 6 to 7 per cent. of coal, due to mechanical stoking, but if it saves no fuel, the automatic stoker may be expected to pay its way into locomotive practice by permitting the use of cheaper fuel. Information obtained from results of practice indicate that runs of 500 miles are made without cleaning fires, an impossibility under similar conditions with hand firing.

The Victor stoker was first applied on the Cincinnati, Indianapolis & Chicago division of the "Big 4" Railroad in January, 1905; by March 5 seven engines were equipped and in operation, five of them being of the Atlantic type and all in fast passenger service. Six stokers were operated through the February blizzards with great satisfaction. They were in the hands of men who had no previous knowledge or experience with the device. The only difficulties resulted from lack of lubrication or breakage by improper methods, such as the breaking of coal in the hopper with a pick. In the daily service between Cincinnati and Indianapolis the engines referred to run 120 miles and return without cleaning fires, this being a result of the ability to carry a clean thin fire and because the fireman had time to properly take care of the grates. It has been demonstrated that ordinary firemen use the stoker very satisfactorily after an experience of only a few days. The operation of the stoker is improved as the men become more familiar with it.

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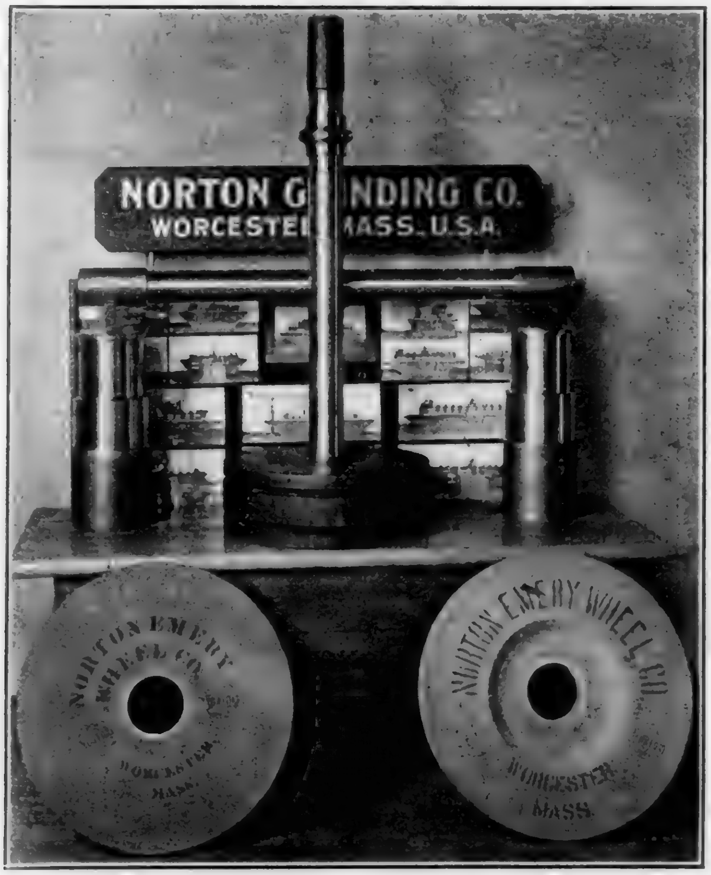

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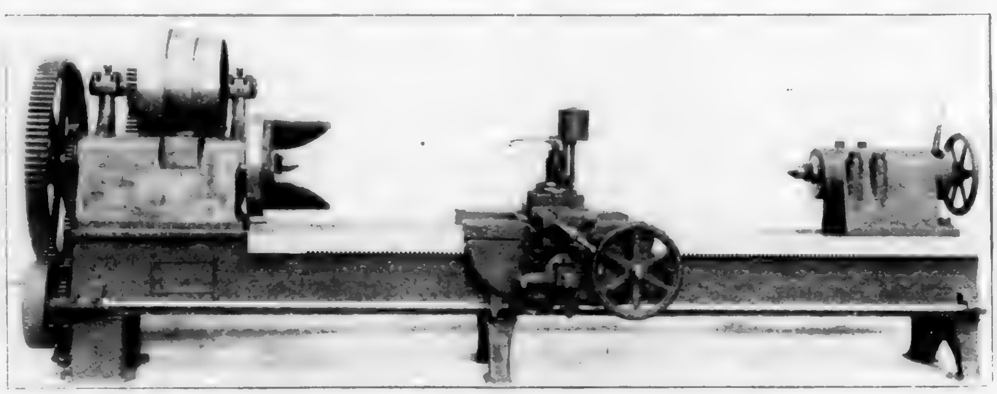

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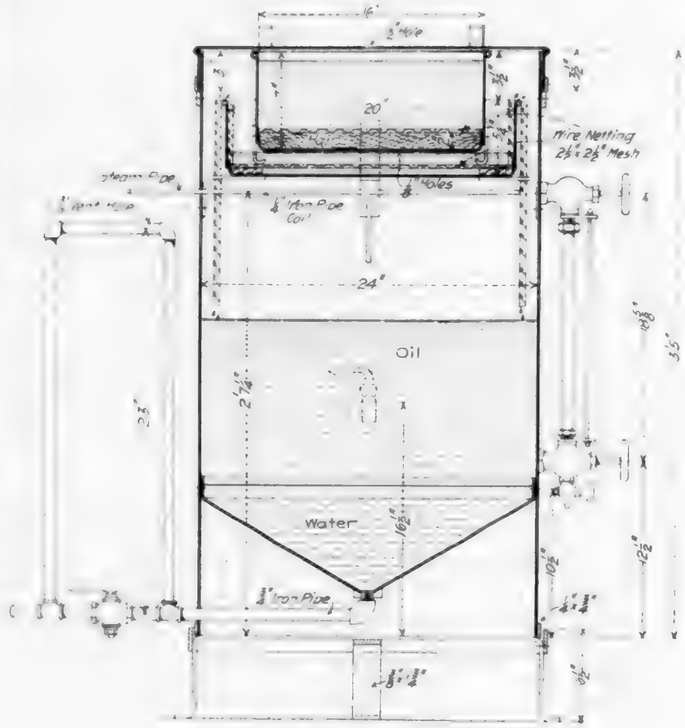

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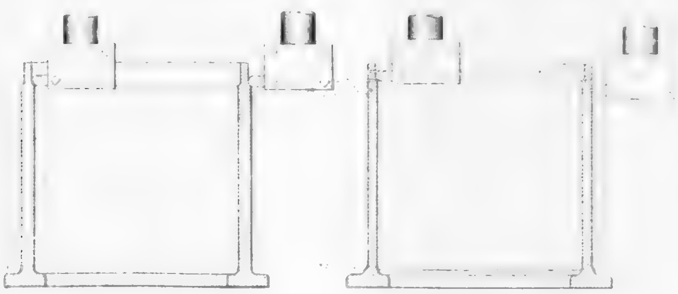

FIRST OPERATION. THIRD OPERATION.

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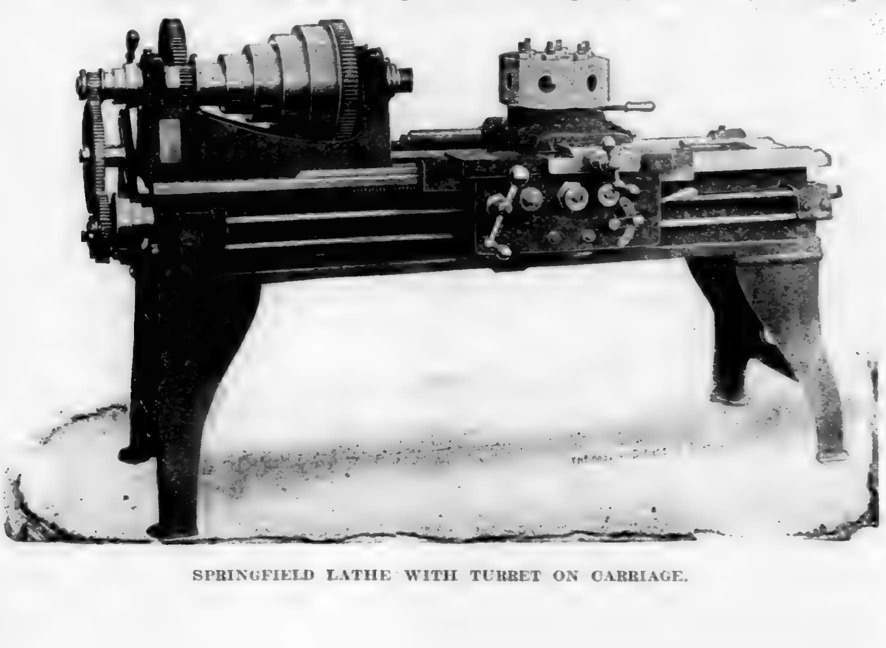

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FIFTY-TON HOPPER COKE CAR.

50-TON STEEL COKE CAR.

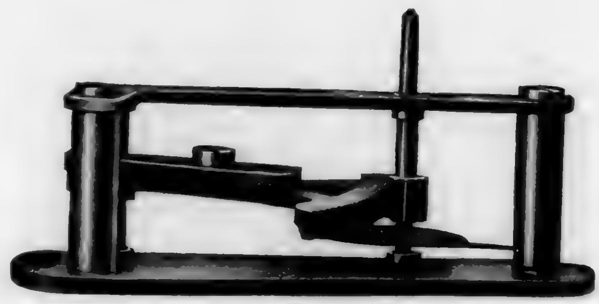
The side dump coke car shown in the illustration was designed and built by the Pressed Steel Car Company to meet the demand of the coke carrying roads for a large capacity car of a minimum light weight provided with a drop door arrangement to insure the rapid discharge of the lading. A large number of these cars are now in operation and are built to the following dimensions:

Length over end sills	41 ft. 9 ins.
Length inside	40 ft. 5 ins.
Center to center of trucks	32 ft. 1 in.
Width of car inside	9 ft. 7 ins.
Height from top of rail to top of sides	12 ft. 0 in.

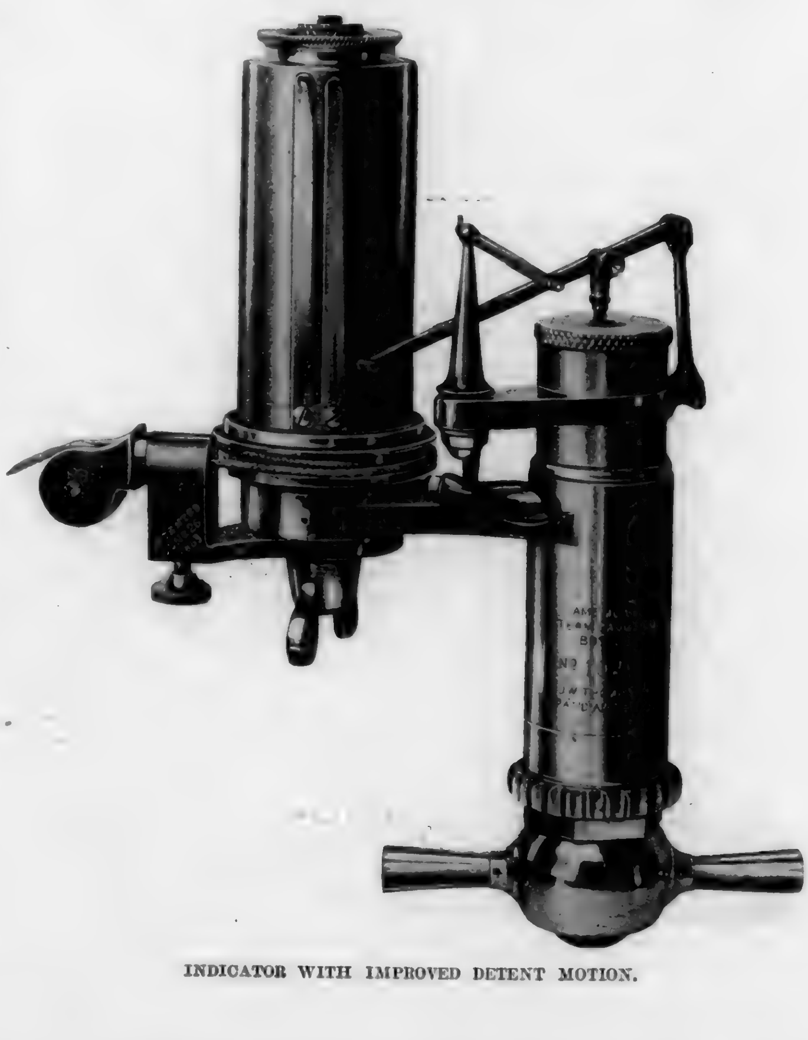
This gives a cubical capacity sufficient for 100,000 lbs. of coke, and with heavy arch bar trucks, having 5½ x 10-in. journals and 700-lb. wheels, the total light weight is only a trifle over 47,000 lbs.

The side and floor slopes present no obstruction to the free discharge of the lading; the doors are of ample proportions and are actuated by a simple and effective mechanism which is operated from one end, the doors on each side of one end being controlled by the operating lever which has a pawl to engage with the ratchet wheel on the outer end of the horizontal shaft shown in the center just above the draft sills, on the other end of which shaft is a double chain sheave to which the ends of the driving chain are anchored. The other ends of the chain are secured to a double sheave on one of the door shafts which are shown parallel with each other below the center sills, and immediately behind this double sheave is a pair of toothed gears transmitting the motion simultaneously to both shafts. Keyed to both door shafts are bent lever arms to which the door links are connected. This arrangement gives a self-lock and eliminates any twisting movement due to the weight of the lading against the doors. The doors are easily operated and several tests have been made with the cars after they have been hauled long distances with full loads of coke and under severe weather conditions and in each instance the entire load has been discharged in less than thirty seconds without any manual labor other than that necessary for operating the doors.

Care of Machine Tools.—A small amount of care and attention regularly given to the average machine tool will maintain it in a high state of efficiency and will add considerably to its length of life.



SHOWING MECHANISM OF STEAM GAUGE.



INDICATOR WITH IMPROVED DETENT MOTION.

NEW STEAM ENGINE INDICATOR.

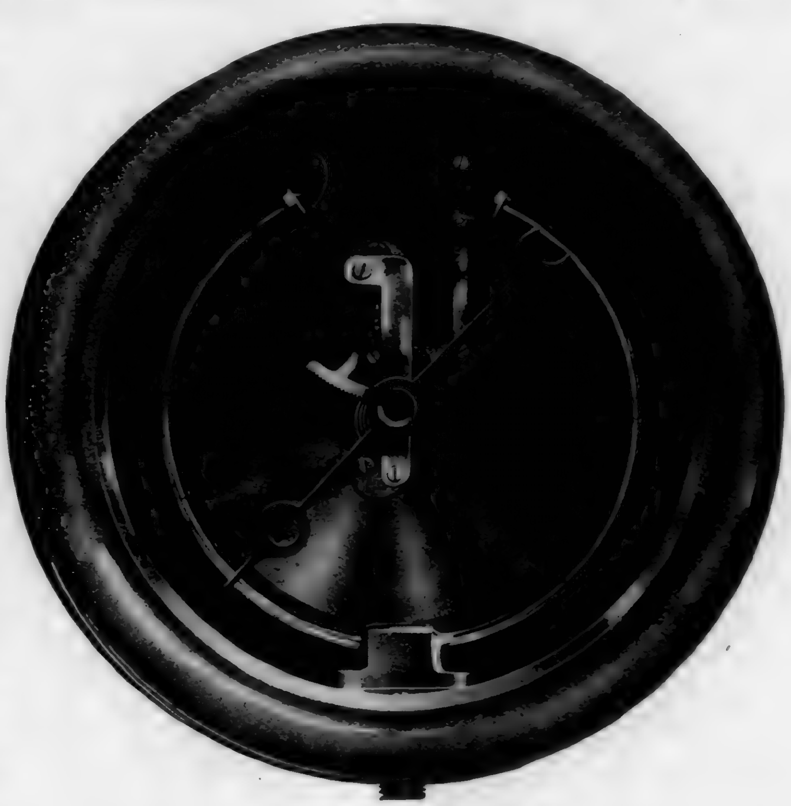
A new improved detent motion for the American-Thompson indicator has been brought out by the American Steam Gauge & Valve Manufacturing Company, of Boston. This attachment renders the well-known American-Thompson indicator specially applicable to high-speed stationary and marine engines; also to locomotives and gas engines. With this attachment it is possible to connect the indicator to high-speed reducing motion and stop the drum of the indicator without unhooking the cord, and, of course, without stopping the engine. The vexation attending the stopping and starting of the drum carriage of the ordinary indicator for changing cards is entirely avoided by this new attachment. This will be specially appreciated by those who are called upon to get as many cards as possible in a short time in a locomotive test, where the difficulties of indicating at best are very great. The locomotive indicator has a 1½-in. paper drum, and is specially adapted for high speed and rapid work, which is necessary to meet the conditions of rapidly changing load.

The detent motion is contained within the paper drum, and is operated by means of a lever below the drum carriage. To stop the drum this lever is moved in the direction travelled by the drum. When released it is returned by the auxiliary spring to a position ⅛ in. beyond the end of the stroke, rendering it impossible for the drum to engage until desired. The drum carriage, having the full tension of the main drum spring, continues to rotate, which prevents whipping and sagging of the cord. This permits the indicator to be used with the detent motion in connection with a reducing wheel directly connected with the indicator. The drum is supported on the spindle by means of a collar held stationary by a pin engaging the slot in the spindle, on which rotates an outer sleeve, which acts as a bearing and guide for the drum. To the stationary collar is fastened the inner end of the auxiliary spring case, which is held stationary in the paper drum. The tension of this spring is such as to cause the drum to return to its position before the return stroke of the drum carriage. When in action the drum is controlled by a pin engaging a hole in the grooved wing at the bottom of the drum. By turning the lever, this pin is lowered on the return stroke of the drum carriage, releasing the drum, which is returned beyond the end of the stroke by the auxiliary spring. The lever is then returned to its original position, allowing the pin to elevate again. When the card is changed and ready to take another diagram, the drum is turned forward by means of the milled rim on top. This causes the pin to engage the hole, being guided by an incline, causing the drum to rotate in the usual manner, the motion being smooth and without shock, there being no chance to break the cord as with the old style pawl and ratchet detent motion.

In connection with this make of indicator the well-known original Thompson parallel motion is used; the ratio of the lever being three to one, makes a very stiff and rigid motion. The piston and other working parts of the instruments are made as light as practicable. The piston head and steam cylinder are made of special composition, which gives an equal expansion under the varying thickness of metal; this is particularly desirable in reducing friction at this point.

IMPROVED LOCOMOTIVE STEAM GAUGE.

The American Steam Gauge & Valve Manufacturing Company has also introduced a new gauge, which is specially worthy of attention by those who are responsible for steam gauges on locomotives. This construction employs a specially heavy tube for the purpose of preventing vibration and rendering the gauge stiff and rigid. Hard German silver plates are used for connections, the screws and pins being of phosphor bronze, to prevent corrosion and undue wear in the working parts. The movement of the gauge is fitted with a wide-faced segment for the purpose of increasing the life, by reducing wear. The pinion and pinion shaft are of one piece of hard phosphor bronze, the segment shaft also being made of



IMPROVED LOCOMOTIVE GAUGE.

the same metal. The top and bottom plates of the movement have deep German silver bushings, giving unusually long bearings for the pinion and segment shafts. By the use of the hard and rigid connections the lost motion in this gauge is very slight, as may be ascertained by moving the parts with the finger. This is an important factor in locomotive service. There is no iron or steel in this gauge. The case is very heavy, the ring screwing down to the shoulder to make it dust proof. The purpose of the improvements is to secure accuracy because of reduction of wear, durability for the same reason, and simplicity contributes to the desired result by reducing to a minimum the number of parts and connections, making the whole combination as short and direct as possible.

PERSONALS.

Mr. J. F. Mann has been appointed general foreman of the Pere Marquette Railway at Saginaw, Mich.

Mr. J. K. Kelker has been appointed master mechanic of the Cincinnati, Hamilton & Dayton, at Lima, Ohio.

Mr. F. L. Fox has been appointed general foreman of the Pere Marquette Railway at Ionia, Mich.

Mr. D. McKinley has been appointed general foreman of the car department of the Pere Marquette Railway at Muskegon, Mich.

Mr. J. M. Gardner has been appointed assistant master mechanic of the Pennsylvania Railroad at Trenton, N. J.

Mr. E. C. Rodie has been appointed general foreman of the machine shops of the Illinois Central Railroad at New Orleans, La.

Mr. F. W. Cooper has been appointed master mechanic of the Lehigh Valley at East Buffalo, N. Y., succeeding Mr. J. H. Fildes, resigned.

Mr. J. P. Dorsey has been appointed master mechanic of the Ohio River division of the Baltimore & Ohio, with headquarters at Parkersburg, W. Va.

Mr. G. W. Tompkins has been appointed master mechanic of the Wabash, Chester & Western Railway, with office at Chester, Ill., to succeed Mr. E. Danks, resigned.

Mr. J. D. Macbeth, roundhouse foreman of the New York, Chicago & St. Louis at Buffalo, has been appointed master mechanic at Conneaut, O., to succeed Mr. E. A. Miller, promoted.

Mr. Alex. Kearney, superintendent of motive power of the Baltimore & Ohio at Pittsburgh, has resigned to become assistant superintendent of motive power of the Norfolk & Western, with headquarters at Norfolk, Va.

Mr. H. C. Van Buskirk has been appointed superintendent of motive power of the Colorado & Southern Railway to succeed Mr. A. L. Studer, resigned. Mr. Van Buskirk was formerly general master mechanic of the Fort Worth & Denver City Railway at Childress, Texas.

Mr. G. W. Rhodes, general superintendent of the Burlington & Missouri River, has resigned, after 25 years of service with the Burlington system, closing a most useful and honorable railroad career, in which he has placed his name permanently among the highest and best American railroad officials.

Mr. E. A. Miller has been promoted from the position of master mechanic of the New York, Chicago & St. Louis Railway to that of superintendent of motive power, with headquarters at Cleveland, O., to succeed Mr. W. L. Gilmore, resigned. Mr. Miller has been master mechanic at Conneaut, O., for 23 years.

Mr. F. H. Clark, who has been superintendent of motive power of the Chicago, Burlington & Quincy Railway since March, 1902, has been appointed general superintendent of motive power of the Burlington lines, his headquarters remaining in Chicago. Mr. F. A. Torrey has been appointed to succeed Mr. Clark as superintendent of motive power.

NEW CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

DYNAMOS.—Bulletin No. 2 from the Burke Electric Company, Erie, Pa., describing their type "AB" and "AM" dynamos for direct current.

FISH AND GAME LAWS OF MAINE.—A folder received from Mr. C. C. Brown, general passenger and ticket agent of the Bangor & Aroostook Railroad, gives in compact form the fish and game laws for the season of 1905-1906.

ELECTRIC FANS, A FEW WORDS ABOUT.—Bulletin No. 54 from the Crocker-Wheeler Company, Ampere, N. J., describes the Davidson propeller fans driven by direct connected motors, which they are prepared to furnish in sizes from 18 to 60 ins.

RAILWAY GENERATORS.—Bulletin No. 52 from the Crocker-Wheeler Company, Ampere, N. J., contains a very complete description of their direct current generators for electric railways. Several typical applications of these generators are illustrated.

BUDA PRODUCTS.—The Buda Foundry & Manufacturing Company are distributing an attractive 6 by 9 in., 225 page 1905 catalog. A few of the lines which this company manufactures are hand, push and inspection cars, railroad velocipedes, track drills, track and wrecking jacks, track construction tools, roadway signs, a complete line of switch stands and signals, crossing gates, wrecking frogs, brake shoes, anti-friction metal, station stoves and the many products of its special work department, the Paige Iron Works. The catalog concludes with 13 pages of useful engineering information.

AIR COMPRESSORS.—The Chicago Pneumatic Tool Company, Chicago, will be pleased to send those who are interested a copy of their new catalog describing the new pattern type G Franklin compressors, which are lighter in construction than the standard Franklin machines.

STAYBOLT IRON.—The Old Dominion Iron & Nail Works Company, Richmond, Va., have issued a pamphlet which presents some interesting facts concerning the advantages of their special vibrating staybolt iron.

TRACK, CONSTRUCTION AND MAINTENANCE.—We have just received from the Buda Foundry & Manufacturing Company, Chicago, Ill., copies of both the English and French editions of their interesting catalog describing the large variety of track and maintenance of way specialties manufactured by them.

"MORE LATHE WORK AND FEWER LATHES."—Under this title the Lodge & Shipley Machine Tool Company, Cincinnati, O., have issued a nicely gotten up and well illustrated catalog which describes in detail the various parts of their Patent Head lathe, which is a quick change gear lathe adapted for high-speed work.

DIRECT CURRENT GENERATORS.—Bulletin No. 46 from the Northern Electrical Manufacturing Company, Madison, Wis., describes and profusely illustrates the details of their direct current generators, which are adapted for furnishing power and light for railroad shops. Several typical applications of these generators are also illustrated.

WESTINGHOUSE CATENARY LINE CONSTRUCTION.—Circular No. 1,110, issued by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., gives a very complete description of their catenary line construction, which is intended for high-tension trolley roads and was especially designed for use in conjunction with their single phase alternating current equipment.

ONE DAY'S WORK.—The Bullard Machine Tool Company, Bridgeport, Conn., have issued bulletin F 537, which illustrates their 42 in. standard boring and turning mill with two swivel heads, and shows how 122 piston packing rings were made in ten hours on one of their machines in the West Albany shops of the New York Central Railroad.

THE WESTINGHOUSE COMPANIES IN THE RAILWAY AND INDUSTRIAL FIELDS.—The publication department of the Westinghouse companies is to be congratulated upon bringing out this handsome and well arranged publication, which briefly but interestingly traces the development of the various Westinghouse companies from their inception to the present time and illustrates a few of their many products.

THE EVOLUTION OF CAR COUPLINGS.—The McConway & Torley Company, Pittsburg, Pa., distributed at the International Railway Congress in Washington an interesting and handsome publication, printed in English and French in parallel columns, which traces the development of car couplings from the old link and pin style to the present time. This company co-operated with Janney in developing his coupler, and was, therefore, the original promoter and manufacturer of the M. C. B. type of coupler.

ELECTRICAL APPARATUS.—The American Electric & Controller Company, 136 Liberty street, New York City, has ready for distribution the following bulletins: No. 1, description of the rheocrat; No. 2, applications of the rheocrat; No. 3, electrically operated switches; No. 4, automatic starters for induction motors; Nos. 5 and 6, applications of automatic starters; No. 7, solenoids for direct and alternating current service; No. 8, applications of solenoids. A suitable binder will be furnished in which to preserve these bulletins.

NOTES.

AMERICAN ELECTRIC & CONTROLLER COMPANY.—This company has removed its office from 12 Dey street to the Electrical Exchange Building, 136 Liberty street, New York City.

AJAX METAL COMPANY.—This company is constructing a new fireproof pattern loft at 52 Richmond street, Philadelphia. The construction is to be of steel. Mitchell Bros. of Philadelphia have the contract for erection.

THE AMERICAN WATER SOFTENER COMPANY.—This company reports the receipt of an order from the Hocking Valley Railway which includes a water softening plant to be installed at their Columbus shops, with a capacity of 25,000 gals. an hour, or 600,000 gals. a day.

MAGNOLIA METAL COMPANY.—Mr. H. W. Toothe has resumed his position in the sales department of this company, with headquarters at 113 Bank street, New York City.

STEAM TURBINE UNIT FOR A RAILROAD.—The Canadian Westinghouse Company, Limited, has sold a 500-k.w. enclosed type turbo-generator unit to the Canadian Pacific Railway, to be installed at Fort William, for supplying power to the various grain elevators at that point. The unit is to operate 3 phase. 600 volt, 7,200 alterations, 3,600 r.p.m.

BUDA FOUNDRY & MANUFACTURING COMPANY.—Mr. James H. Bannerman, formerly mechanical superintendent of the Tennessee Central, has been added to the force of travelling representatives and will represent the metal department, demonstrating to the mechanical departments of the railroads the advantages of some of the new compositions which they have recently placed on the market.

THE GARFORD COMPANY.—This company, of Cleveland, Ohio. has purchased the Cleveland and Elgin factories of the Federal Manufacturing Company, and will continue to manufacture railway curtains and curtain fixtures. Mr. Arthur L. Garford is president of the company. The capital stock is $400,000, and by this transfer the liquidation of the Federal Manufacturing Company is completed.

DAVIS EXPANSION BORING TOOL.—Mr. Mord Roberts, who was well known in his railroad career, has entered the field of manufacturing railroad appliances as general manager of the Davis Expansion Boring Tool Company, 202 S. Commercial street, St. Louis, Mo. Mr. Roberts' reputation is itself sufficient guarantee of the value of the Davis tools, which are specially adapted to use in boring mills, lathes and drill presses. Those interested in improving their shop output may communicate with Mr. Roberts at the address given.

WM. B. SCAIFE & SONS COMPANY.—The plant of the Driggs-Seabury Ordinance Corporation at Sharon, Pa., which was designed, manufactured and erected by Wm. B. Scaife & Sons Company of Pittsburgh, is almost completed and consists of a foundry, 100 by 440 ft.; forge shop, 109 by 160 ft.; machine shop, 60 by 260 ft.; power-house, 40 by 180 ft., and shell building, 160 by 250 ft.; all of steel frame construction. They have also designed and erected a mill building, 172 by 78 ft., of steel frame construction, covered with corrugated iron, for the Broomal Iron & Steel Company, Belington, W. Va., and have been awarded contracts by the American Lime & Stone Company for a steel frame trestle to be erected at Bellefonte, Pa., and a steel frame tipple about 400 ft. long for their Buffalo Run plant.

A LARGE ORDER FOR CARS.—The Baltimore & Ohio has awarded a contract of approximately $12,000,000 for 10,000 freight cars, 2,000 steel hoppers to be built at Berwick, Pa., and 250 refrigerators at Chicago by the American Car & Foundry Company; the Pressed Steel Car Company will build 2,000 steel coal cars; the Western Steel Car & Foundry Company, Chicago, will build 1,000 box cars; the Standard Steel Car Company will build 1,500 composite gondolas; the Cambria Steel Car Company 2,000 gondolas and the Rodger Ballast Car Company 250 ballast cars. With the recent large order for locomotives, the equipment orders placed by the Baltimore & Ohio last month aggregate approximately $16,000,000. This car order is believed to be the largest order placed at one time.

ERIE HEATING COMPANY.—Mr. William White, who was formerly master mechanic of the Lake Erie & Western at Lima, Ohio, has become associated with the Erie Heating Company Railway Exchange, Chicago, and has given his attention to the improved roundhouse facilities for boiler washing and steam heating in connection with the system which this company developed and applied recently to the new round house of the Lake Shore & Michigan Southern Railway at Elkhart, Ind. Mr. White's railroad experience and wide acquaintance are exceedingly valuable assets in introducing apparatus of this kind, where an intimate knowledge of railroad conditions is necessary. The efforts of this company lie in the direction of improved roundhouse facilities, than which there is nothing more important to-day in the railroad operating problem.

FISHING IN NEW ENGLAND.—Those who have not taken a holiday for the spring fishing need to be reminded of the opportunities offered by New England, which are reported to be exceedingly good this year for the "wise man's sport." Lake Winnipesaukee for bass, cusk, pickerel and trout. New Found Lake for land-locked salmon. Lake Sunapee and the Connecticut lakes supply excellent reports of sport this season. In Vermont, Lakes Memphremagog, Champlain and Willoughby furnish attractive fishing stories, and in Maine Sebago, Rangeley, Moosehead, Grand Lake and the other 1,600 ponds and lakes are calling to the angler. A 2-cent stamp sent to the general passenger department of the Boston & Maine Railroad, Boston, Mass., will bring a booklet entitled "Fishing and Hunting," which is worth while for any sportsman to take the trouble to secure. The first salmon in the famous Bangor Pool was landed twenty minutes after the law was off on April 1. The fishermen started at Bangor Pool at 12.01 A. M. on that day and the fishing season went on in earnest. Reports indicate that the salmon and trout fishing is excellent this year in the lakes and ponds of Maine, including the Rangeleys, Sebago, Moosehead and the Dead River region.

THE AMERICAN STEEL FOUNDRIES.—This concern has just been awarded a contract by the Norfolk & Western Railway for body and truck bolsters for 4,000 cars of different designs and capacities. These cars will be built at the Roanoke shops of the railroad company, and by the various car builders. The bolsters for all of these cars will be made entirely of cast steel, and the fact that this large order has been awarded to one company is significant of the good opinion of cast steel for this purpose. The American Steel Foundries have moved their general offices from 74 Broadway, New York, to No. 42 Broadway. The district manager's office has been moved from Alliance, Ohio, to Sharon, Pa., where new office buildings are being erected. This company has received an order from the Atchison, Topeka & Santa Fe Railway for 2,000 cast steel truck bolsters for 1,000 combination stock and coke cars, to be built by the American Car & Foundry Company; also orders for 1,000 truck bolsters to be applied to box cars for the Great Northern Railway; cast steel truck and body bolsters for 2,000 Detroit Southern Railroad cars; R. E. Janney couplers for 1,500 Chesapeake & Ohio cars and for 3,000 Lehigh Valley cars, and approximately 15 tons of steel castings for each of 250 Baltimore & Ohio locomotives to be built by the Baldwin Locomotive Works.

AMERICAN RAILWAY APPLIANCE EXHIBITION.

The following list presents the names of firms and others who are members or exhibitors of the exhibition held in connection with the International Railway Congress in Washington May 3 to 14:

Acme White Lead & Color Works, Detroit, Mich.; Adams & Westlake Co., Chicago, Ill.; Ajax Manufacturing Co., Cleveland, O.; Ajax Metal Co., Philadelphia, Pa.; American Brake Co., St. Louis, Mo.; American Brake Shoe & Foundry Co., Mahwah, N. J.; American Bridge Co., Pittsburg, Pa.; American Car & Foundry Co., New York and St. Louis; AMERICAN ENGINEER AND RAILROAD JOURNAL, New York; American Hoist & Derrick Co., St. Paul, Minn.; American Iron & Steel Manufacturing Co., Lebanon, Pa.; American Lock Nut Co., Boston, Mass.; American Locomotive Appliance Co., Washington, D. C.; American Locomotive Co., New York; American Machinery Co., Willoughby, O.; American Radiator Co., Chicago, Ill.; American Railway Supply Co., New York; American Sheet & Tinplate Co., Pittsburg, Pa.; American Steam Gauge & Valve Mfg. Co., Boston, Mass.; American Steel Foundries, New York; American Steel & Wire Co., Pittsburg, Pa.; American Trackbarrow, Lowell, Mass.; American Valve & Meter Co., Cincinnati, O.; American Water Softener Co., Philadelphia, Pa.; J. S. Andrews & Co., New York; Anglo-American Varnish Co., Newark, N. J.; Appleton Car Mover Co., Appleton, Wis.; Armstrong Bros. Tool Co., Chicago, Ill.; Art Metal Construction Co., Jamestown, N. Y.; Ashcroft Mfg. Co., New York; Ashton Valve Co., Boston, Mass.; Atha, Benjamin & Co., Newark, N. J.; Atlas Portland Cement Co., New York; Aurora Automatic Machine Co., Aurora, Ill.; Automatic Valve Grinding Machine Co., Knoxville, Tenn.; Automatic Ventilator Co., New York; Charles Whiting Baker, New York; William C. Baker, New York; Baldwin Locomotive Works, Philadelphia, Pa.; Barbour Stockwell Co., Cambridgeport, Mass.; Barker Mail Crane Co., Clinton, Iowa; Barney & Smith Car Co., Dayton, O.; Barnett Equipment Co., Newark, N. J.; Lindon W. Bates, New York; Beaver Dam Malleable Iron Co., Beaver Dam, Wis.; Beckwith-Chandler Co., New York; Belle City Malleable Iron Co., Racine, Wis.; Berry Bros. Ltd., Detroit, Mich.; C. H. Besley & Co., Chicago, Ill.; Bethlehem Steel Co., South Bethlehem, Pa.; Bettendorf Axle Co., Davenport, Iowa; Wm. T. Bonner Co., Boston, Mass.; Booth Water Softening Co., New York; L. J. Bordo Co., Philadelphia, Pa.; S. F. Bowser & Co., Fort Wayne, Ind.; Bradford Draft Gear Co., Bradford, Ill.; Bradley, Osgood & Sons, Worcester, Mass.; Brady Brass Co., Jersey City, N. J.; Bridgeport, Conn.; J. G. Brill Co., Philadelphia, Pa.; Harold P. Brown, New York; Brown & Co., Inc., Pittsburg, Pa.; Brown Hoisting Machinery Co., Cleveland, O.; Bryant Electric Co., Bridgeport, Conn.; Buckeye Steel Castings Co., Columbus, O.; Bucyrus Co., South Milwaukee, Wis.; Buda Foundry & Mfg. Co., Chicago, Ill.;

Buffalo Forge Co., Buffalo, N. Y.; Bullard Machine Tool Co., Bridgeport, Conn.; Burnham, Williams & Co., Philadelphia, Pa.; Butler Drawbar Attachment Co., Cleveland, O.; Cambria Steel Co., Philadelphia, Pa.; Camel Co., Chicago, Ill.; Carbon Steel Co., New York; Philip Carey Mfg. Co., Cincinnati, O.; Carnegie Steel Co., Pittsburg, Pa.; Chenoweth & McNamee, Brooklyn, N. Y.; Chicago Car Heating Co., Chicago, Ill.; Chicago-Cleveland Car Roofing Co., Chicago, Ill.; Chicago Pneumatic Tool Co., Chicago, Ill.; Chicago Railway Equipment Co., Chicago, Ill.; Chicago Varnish Co., Chicago, Ill.; Chilton Paint Co., New York; Cleveland Car Specialty Co., Cleveland, O.; Cleveland City Forge & Iron Co., Cleveland, O.; Cleveland Frog & Crossing Co., Cleveland, O.; Cling Surface Co., Buffalo, N. Y.; W. H. Coe Mfg. Co., Providence, R. I.; Columbia Fire Cracker Co., Bucyrus, O.; Columbia Nut & Bolt Co., Inc., Bridgeport, Conn.; Commonwealth Steel Co., St. Louis, Mo.; J. B. & J. M. Cornell Co., New York; Consolidated Car Heating Co., New York; Consolidated Cross-Tie Co., New York; Consolidated Railway Electric Lighting & Equipment Co., New York; Consolidated Safety Valve Co., New York; Continuous Rail Joint Co. of America, Newark, N. J.; Continuous Rail & Mfg. Co.; Indianapolis, Ind.; W. W. Converse & Co., Palmer, Mass.; Cooper Hewitt Electric Co., New York; Crago & Bohrnstedt, Cadotte, Wis.; Crane Co., Chicago, Ill.; Crocker-Wheeler Co., Ampere, N. J.; Curtain Supply Co., Chicago, Ill.; Damascus Brake Beam Co., St. Louis, Mo.; Damascus Bronze Co., Pittsburg, Pa.; Davis Expansion Tool Boring Co., St. Louis, Mo.; John Davis, Co., Chicago, Ill.; Davis Pressed Steel Co., Wilmington, Del.; Dearborn Drug & Chemical Co., Chicago, Ill.; Detroit Lubricator Co., Detroit, Mich.; Detroit Seamless Tube Co., Detroit, Mich.; F. W. Devoe & C. T. Reynolds Co., New York; Diamond Rubber Co., Akron, O.; Paul Dickinson, Chicago, Ill.; Dilworth, Porter & Co., Pittsburg, Pa.; Draper Mfg. Co., Port Huron, Mich.; Dreses Machine Tool Co., Cincinnati, O.; Dressel Railway Lamp Works, New York; Duff Mfg. Co., Pittsburg, Pa.; Dukesmith Air Brake Co., Pittsburg, Pa.; Eastern Granite Roofing Co., New York; Edison Mfg. Co., New York; Edna Smelting & Refining Co., Cincinnati, O.; O. M. Edwards Co., Syracuse, N. Y.; Electric Controller & Supply Co., Cleveland, O.; Electric Storage Battery Co., Philadelphia, Pa.; Electro-Dynamic Co., Bayonne, N. J.; Elliott-Fisher Co., Philadelphia, Pa.; Elliott Frog & Switch Co., East St. Louis, Ill.; Empire Safety Tread Co., Brooklyn, N. Y.; Ewald Iron Co., St. Louis, Mo.; Fairbanks, Morse & Co., Chicago, Ill.; Falls Hollow Staybolt Co., Cuyahoga Falls, O.; Farlow Draft Gear Co., Baltimore, Md.; Federal Co., Chicago, Ill.; Federal Mfg. Co., Elyria, O.; Flannery Bolt Co., Pittsburg, Pa.; Flood & Conklin Co., Newark, N. J.; Foote, Burt & Co., Cleveland, O.; Foster Engineering Co., Newark, N. J.; Walter H. Foster, New York; Franklin Mfg. Co., Franklin, Pa.; Franklin Railway Supply Co., Franklin, Pa.; Frost Railway Supply Co., Detroit Mich.; Fuller Bros. & Co., New York; Galena Signal Oil Co., Franklin, Pa.; Garlock Packing Co., New York; Harney J. Gehr, Waynesboro, Pa.; General Electric Co., New York; General Railway Signal Co., Buffalo, N. Y.; German-American Car Lines, Chicago, Ill.; Gold Car Heating & Lighting Co, New York; Wm. Goldie, Jr., & Co., West Bay City, Mich.; Goldschmidt Thermit Co., New York; Goodwin Car Co., New York; Gould Coupler Co., New York; Greenlee Bros. & Co., Rockford, Ill.; Griffin Wheel Co., Chicago, Ill.; Grip Nut Co., Chicago, Ill.; Hageman Metallic Hose Co., Chicago, Ill.; Hale & Kilburn Mfg. Co., Philadelphia, Pa.; Hall Signal Co., New York; Handlin-Buck Mfg. Co., St. Louis, Mo.; Hart Steel Co., New York; Hartford Rubber Works Co., Hartford, Conn.; N. L. Hayden Mfg. Co., Columbus, O.; Heath & Milligan Mfg. Co., Chicago, Ill.; Hendy Machine Co., Torrington, Conn.; Hess-Bright Mfg. Co., Philadelphia, Pa.; Hewitt Mfg. Co., Chicago, Ill.; Heywood Bros. & Wakefield Co., Wakefield, Mass.; Hill, Clarke & Co., Boston, Mass.; Home Rubber Co., Trenton, N. J.; Homestead Valve Mfg. Co., Pittsburg, Pa.; Hubbard & Co., Pittsburg, Pa.; Hunt-Spiller Mfg. Corporation, South Boston, Mass.; Hussey-Binns Shovel Co., Pittsburg, Pa.; C. B. Hutchins & Sons, Detroit, Mich.; Illinois Steel Co., Chicago, Ill.; Independent Railroad Supply Co., Chicago, Ill.; Industrial Works, Bay City, Mich.; Ingersoll-Sergeant Drill Co., New York; Ingoldsby Automatic Car Co., St. Louis, Mo.; International Correspondence Schools, Railway Department, Chicago, Ill.; International Creosoting & Construction Co., Galveston, Tex.; International Fence & Fireproofing Co., Columbus, O.; International Nickel Co., New York; *International Railway Journal*, Philadelphia, Pa.; Interstate Engineering Co., Bedford, O.; Iron City Tool Works, Pittsburg, Pa.; A. H. Jackson, Fremont, O.; Jenkins Bros., New York; W. H. Johns-Manville Co., New York; J. R. Johnson & Co., Richmond, Va.; Jones & Laughlin Steel Co., Pittsburg, Pa.; B. M. Jones & Co., Boston, Mass.; Philip S. Justice & Co., Philadelphia, Pa.; Kalamazoo Railway Supply Co., Kalamazoo, Mich.; Keefer Railway Tie Co., Cincinnati, O.; Keith Mfg. Co., Sagamore, Mass.; Thomas Kendrick, Glenwood Springs, Col.; Kennicott Water Softener Co., Chicago, Ill.; Edwin R. Kent & Co., Chicago, Ill.; Kerr Turbine Co., Wellsville, N. Y.; Keystone Lantern Co., Philadelphia, Pa.; King-Lawson Car Co., Middletown, Pa.; Kinsman Block System Co., New York; Krips-Mason Machine Co., Philadelphia, Pa.; Lackawanna Steel Co., New York; Landis Machine Co., Waynesboro, Pa.; Landis Tool Co., Waynesboro, Pa.; Lawrence Switch Co., Duluth, Minn.; Lehigh Portland Cement Co., Allentown, Pa.; C. Lembecke & Co., New York; J. S. Leslie, Paterson, N. J.; Gustav Lindenthal, New York; Lock Joint Pipe Co., New York; Locomotive Appliance Co., Chicago, Ill.; Lodge & Shipley Machine Tool Co., Cincinnati, O.; Lorain Steel Co., Philadelphia, Pa.; Lord Electric Co., Boston, Mass.; F. H. Lovell & Co., New York; Lowe Bros. Co., Dayton, O.; John Lucas & Co., Philadelphia, Pa.; Lukens Iron & Steel Co., Coatesville, Pa.; Lunkenheimer Co., Cincinnati, O.; MacLeod, Walter & Co., Cincinnati, O.; Madeira, Hill & Co., Philadelphia, Pa.; Magnus Metal Co., Buffalo, N. Y.; Mahoney Railroad Ditching Machine Co., Vincennes, Ind.; A. Major, New York; Manning, Maxwell & Moore, New York; Manufacturing Co., Carlisle, Pa.; Maryland Steel Co., Philadelphia, Pa.; Mason Regulator Co., Boston, Mass.; John W. Masury & Son, New York; Matthews-Northrup Works, Buffalo, N. Y.; McConway & Torley Co., Pittsburg, Pa.; McCord & Co., Chicago, Ill.; Mechanical Rubber Co., Chicago, Ill.; Mechanical Rubber Works, Cleveland, O.; Merrill-Stevens Mfg. Co., Kalamazoo, Mich.; Merritt & Co., Philadelphia, Pa.; Middletown Car Works, Middletown, Pa.; Midvale Steel Co., Philadelphia, Pa.; Miller Anchor Co., Norwalk, O.; W. H. Miner Co., Chicago, Ill.; Monarch Coupler Co., Detroit, Mich.; Moran Flexible Joint Co., Louisville, Ky.; Modern Frog & Crossing Works, Chicago, Ill.; Morse Code (Telegraph) Signal Co., Milwaukee, Wis.; Morse Twist Drill Co., New Bedford, Mass.; Municipal Engineering & Contracting Co., Chicago, Ill.; Murphy Varnish Co., Newark, N. J.; Nathan Mfg. Co., New York; National Lock Washer Co., Newark, N. J.; National Malleable Castings Co., Cleveland, O.; National Meter Co., New York; National Railway Publication Co., New York; National Surface Guard Co., Chicago, Ill.; National Tube Co., Pittsburg, Pa.; Nernst Lamp Co., Pittsburg, Pa.; New Jersey Tube Co., Newark, N. J.; Newman Clock Co., Chicago, Ill.; New York Air Brake Co., New York; New York Belting & Packing Co., New York; George P. Nichols & Bro., Chicago, Ill.; Niles-Bement-Pond Co., New York; Norfolk Creosoting Co., Norfolk, Va.; Norton Grinding Co., Worcester, Mass.; Odenkirk Switch & Signal Co., Cleveland, O.; Ohio Injector Co., Chicago, Ill.; Oil & Waste Saving Machine Co., Philadelphia, Pa.; David E. Olds, Newark, N. J.; Old Dominion Iron & Nail Works, Richmond, Va.; Oliver Machinery Co., Grand Rapids, Mich.; Otto Gas Engine Works, Chicago, Ill.; Pantasote Co., New York; Patterson Sargent Co., Cleveland, O.; Peerless Rubber Mfg. Co., New York; Pennsylvania Steel Co., Philadelphia, Pa.; Perry Side Bearing Co., Joliet, Ill.; Pettibone, Muliken & Co., Chicago, Ill.; Pitt Car Gate Co., New York; Pittsburg Spring & Steel Co., Pittsburg, Pa.; H. K. Porter & Co., Pittsburg, Pa.; Pratt & Lambert, New York; Pratt & Letchworth Co., Buffalo, N. Y.; Pressed Car Steel Co., New York; Prosser, Thomas & Son, New York; Protectus Co., Philadelphia, Pa.; Pyle-National Electric Headlight Co., Chicago, Ill.; Quaker City Rubber Co., Philadelphia, Pa.; *Railroad Gazette*, New York; Railroad Supply Co., Chicago, Ill.; *Railway Age*, Chicago, Ill.; *Railway and Locomotive Engineering*, New York; Railway Appliances Co., Chicago, Ill.; Railway Equipment & Publication Co., New York; Railway List Co., Chicago, Ill.; *Railway Master Mechanic*, Chicago, Ill.; Railway Materials Co., Chicago, Ill.; *Railway and Engineering Review*, Chicago, Ill.; Railway Steel-Spring Co., New York; Ralston Car Co., Chicago, Ill.; Ramapo Iron Works, Hillburn, N. Y.; Rand Drill Co., New York; Raymond Concrete Pile Co., Chicago, Ill.; F. E. Reed Co., Worcester, Mass.; Arthur E. Rendle, New York; Robins Conveying Belt Co., New York; Rockwell Engineering Co., New York; Roger Ballast Car Co., Chicago, Ill.; Rostand Mfg. Co., New Haven, Conn.; G. Rouy, New York; Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.; Safety Car Heating & Lighting Co., New York; St. Louis Car Co., St. Louis, Mo.; St. Louis Car Wheel Co., St. Louis, Mo.; St. Louis Expanded Metal Fireproofing Co., St. Louis, Mo.; St. Louis Malleable Casting Co., St. Louis, Mo.; Schoen Steel Wheel Co., Philadelphia, Pa.; Scranton Bolt & Nut Co., Scranton, Pa.; Scullin-Gallagher Iron & Steel Co., St. Louis, Mo.; Seitz Bros., Tiffin, O.; Wm. Sellers & Co., Inc., Philadelphia, Pa.; Shewin-Williams Co., Cleveland, O.; Simmons Hardware Co., St. Louis, Mo.; Simplex Railway Appliance Co., Chicago, Ill.; M. A. Singer, New York; James B. Sipe & Co., Allegheny, Pa.; Smith Boltless Rail Joint Co., Homestead, Pa.; Edward Smith & Co., New York; John G. Snyder, Altoona, Pa.; South Atlantic Car & Mfg. Co., Waycross, Ga.; Southern Exchange Co., New York; Spaulding Print Paper Co., Boston, Mass.; Sprague Electric Co., New York; N. Stafford Co., New York; Standard Coupler Co., New York; Standard Paint Co., New York; Standard Sectional-Automatic Car Journal Lubricator, New York; Standard Steel Works, Philadelphia, Pa.; Star Brass Mfg. Co., Boston, Mass.; A. C. Stiles Metal Co., New Haven, Conn.; Storrs Mica Co., Oswego, New York; S. H. Summerscales, Winnipeg, Canada; Swan & Finch Co., New York; T. H. Symington Co., Baltimore, Md.; Talmage Mfg. Co., Cleveland, O.; J. Thiollier, New York; Thomas Tanty Co., New York; Trojan Car Coupler Co., New York; Trussed Concrete Steel Co., Detroit, Mich.; Tyler Tube & Pipe Co., New York; H. B. Underwood & Co., Philadelphia, Pa.; Underwood Typewriter Co., New York; Union Spring & Mfg. Co., Pittsburg, Pa.; Union Steel Casting Co., Pittsburg, Pa.; Union Switch & Signal Co., Pittsburg, Pa.; United Injector Co., New York; United & Globe Rubber Mfg. Co., Trenton, N. J.; United States Light & Heating Co., New York; United States Metal & Mfg. Co., New York; United States Steel Products Export Co., New York; Universal Railway Supply Co., Baltimore, Md.; Vacuum Cleaner Co., New York; Valentine & Co., New York; W. T. Van Dorn Co., Chicago, Ill.; Verona Tool Works, Pittsburg, Pa.; Victor Stoker Co., Cincinnati, O.; J. H. Walters, Augusta, Ga.; Washburn Co., Minneapolis, Minn.; Weber Railway Joint Mfg. Co., New York; Wellman & Street, New York; Wellman-Seaver-Morgan Co., New York; Wells Light Mfg. Co., New York; West Disinfecting Co., New York; Western Steel Car & Foundry Co., Chicago, Ill.; Western Tube Co., Kewanee, Ill.; Western Wheel Scraper Co., Aurora, Ill.; Westinghouse Air Brake Co., Pittsburg, Pa.; Westinghouse Automatic Air & Steam Coupler Co., Pittsburg, Pa.; Westinghouse, Church, Kerr & Co., New York; Westinghouse Electric & Mfg. Co., Pittsburg, Pa.; Westinghouse Machine Co., East Pittsburg, Pa.; Westinghouse Traction Brake Co., Pittsburg, Pa.; Wm. Wharton, Jr., & Co., Inc., Philadelphia, Pa.; Wheel Truing Brake Shoe Co., Detroit, Mich.; White Enamel Refrigerator Co., St. Paul, Minn.; Williams, Brown & Earle, Philadelphia, Pa.; James G. Wilson Mfg. Co., New York; G. S. Wood, Chicago, Ill.; R. O. Wood & Co., Philadelphia, Pa.; Wymen & Gordon, Worcester, Mass.; Yale & Towne Mfg. Co., New York; Yawman & Erbe Mfg. Co., Rochester, N. Y.; Yetman Transmitting Typewriter Co., New York.

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CONTENTS.

MASTER MECHANICS' ASSOCIATION.

THE THIRTY-EIGHTH ANNUAL CONVENTION.

The convention was opened June 14 at the Oriental Hotel, Manhattan Beach, by the president, Mr. P. H. Peck. Among other matters, his annual address briefly mentioned the AMERICAN ENGINEER tests, announcing the fact that the necessary funds for that work were in the hands of the association. The speaker also referred to the tests on locomotive boilers which are to be undertaken in the future. The adoption of representative membership of the association—which had already met with responses representing about 25 per cent. of the total number of locomotives in the country—would provide funds for such investigations in the future. The president thought that much valuable work could be done in standardizing locomotive parts, as had been done by the Master Car Builders' Association. In the matter of shop practice, he deplored the conditions requiring "100-ton locomotives to be maintained in 50-ton shops." The address was brief, and touched upon the most important work before the association.

The report of the secretary showed the total number of active members to be 738; associate, 17, and honorary, 38; a total of 793. The secretary announced that the amount in hand for the AMERICAN ENGINEER tests was $3,077.34. According to the change in the constitution last year, the railroads had been invited to appoint representative members, responses having been received from 30 roads. The secretary explained that no increase of dues was contemplated, the cost of conducting tests and experiments, however, would be provided by assessments among the railroads through representative membership.

The treasurer's report showed a balance of $1,535.29 in the treasury, with all bills paid.

At this point Mr. Edward Sauvage, consulting engineer of the Western Railway of France, was given the privileges of the floor. They were also given to Mr. J. D. Benjamin, representing the Traveling Engineers' Association. Mr. Godfrey W. Rhodes was elected an honorary member of the association, in view of his retirement from railroad service and his past valuable services to the association. This is a deserved tribute to Mr. Rhodes, than whom no member of the association has been more helpful or faithful for more than 20 years.

COMMITTEE REPORTS.

Some of these reports appear in abstract in this issue and others will appear next month. The discussions will be referred to separately, as follows:

PROPER LOADING OF LOCOMOTIVES.—Mr. C. H. Hogan presented this report, a special feature of which is the list of articles on the subject of loading of locomotives which have appeared in the technical press and before the technical associations. In addition to this list, the report includes opinions of a number of members of the association on the proper assignment of loads, which were very briefly stated. Mr. Hogan emphasized the importance of reducing the number of cars to carry a given load, and strongly recommended the use of dynamometer cars in rating locomotives. Mr. Wallace (D., M. & N.) thought that the rating of locomotives should be left to the officers on the divisions where the engines are used. Mr. H. H. Vaughan (Canadian Pacific) thought it would be valuable to know from a number of roads the percentage of theoretical tonnage which could be handled satisfactorily. He considered it economical to carry as heavy a load as practicable without taking too long time on the road. The time was more a transportation than a mechanical question. Reductions could be made occasionally when special conditions caused undue detentions. His remarks tended toward the opinion that, within reasonable limits, (say speeds of 10 to 15 miles an hour), the heavier locomotives are loaded the better. He would like to know of any use of a reduced rating to take care of poor condition of engines because of having been long out of the shops. Mr. G. R. Henderson pointed to the facts that schedules are usually prepared by transportation officials without considering mechanical questions, and that officials gave a high place to large tonnage without considering whether it was economically handled. Mr. F. H. Clark (C., B. & Q.) agreed with Mr. Vaughan as speeds of 10 to 15 miles per hour, the economical loading of locomotives being that which may be handled at such speeds.

Mr. E. Sauvage spoke of locomotive loading methods in France, where fictitious grades were used in order to take account of momentum. Tonnages were fixed for fair conditions, and extra premiums were given engineers for taking extra loads. He also referred to the payment of money premiums to engineers in France. Loading was not too heavy in France, because the cost was known to increase with overloading. He spoke too briefly on this important question. Mr. A. E. Manchester (C., M. & St. P. Ry.) spoke of a method whereby the division superintendent kept a daily statement of tonnage handled and coal used to haul it. The figures were almost instantly available, which made it possible to keep very close check on the cost of fuel and the condition of locomotives, the condition being immediately reflected in the cost. He laid special stress upon the necessity of providing "filling up" points, where additional tonnage may be taken if it can be hauled, trains to be started out with loads which would be sure to get over the road. This would interest the men in the tonnage as well as the mileage. Mr. F. M. Whyte suggested paying train and engine crews on the tonnage basis.

LOCOMOTIVE TESTS AT ST. LOUIS EXPOSITION.—Mr. F. H. Clark presented this brief report, and stated that the final records of the tests of eight locomotives at St. Louis were very nearly ready for the printer, and would appear in book form. The committee was continued for report next year.

REPORTS OF COMMITTEES.

LOCOMOTIVE DRIVING AND TRUCK AXLES AND LOCOMOTIVE FORGINGS.—Mr. Forsyth moved that the proposed specifications be submitted to letter ballot. Carried.

SHRINKAGE ALLOWANCE FOR TIRES.—Mr. F. F. Gaines (P. & R. Ry.) did not see why there should be any discrimination as to increasing shrinkage for different diameters. He also approved of heavier wheel treads for cast steel centers. Mr. G. W. West supported the opinion, and had found it desirable to increase the shrinkage to guard against loose tires. Mr. A. E. Manchester believed that a return to the heavy rims used with cast iron was necessary. Cast steel wheels had been made too light to secure sufficient arch effect between spokes. Mr. McIntosh did not consider cast steel at fault, but rather the light sections. Mr. W. E. Symons raised the question of the possible compression of filling blocks of wheels with cut rims. He desired further investigation of this by the committee. Mr. F. M. Whyte spoke of the deformation of the wheel centers by the shrinkage of tires, giving figures from a test which indicated the necessity to strengthen spokes as well as rims. In the early application of cast steel the temptation to save too much weight was yielded to. Mr. Deems moved to refer the subject back to the committee to consider the matter of design of wheel centers, as well as shrinkage of tires.

MOTIVE POWER TERMINALS.—Mr. D. R. McBain presented this report. Mr. H. H. Vaughan spoke of the recent improvements in roundhouses and equipments for them on the Lake Shore and Canadian Pacific roads. He had observed good results with direct radiation systems. Mr. Gaines emphasized the importance of good track arrangements at roundhouses. Ash handling facilities and heating systems were discussed, but nothing new was recommended. Mr. F. M. Whyte had found that mechanical devices for handling ashes do not meet with favor and that a large majority prefer the pit method.

WATER SOFTENING FOR LOCOMOTIVE USE.—Mr. Manchester spoke in favor of tender tank treatment for use as a preliminary to the installation of water treating plants. Mr. Pratt preferred tender tank treatment to no treatment at all. Mr. Walsh expressed appreciation of water treating plants, but he was using tender treatment where the road could not afford to apply treating plants. There was comparatively little discussion.

SERVICE OF LOCOMOTIVES.—This report revealed the surprising fact that the total time which a locomotive is in the hands of the motive power department is usually less than 25 per cent.; that the actual running time was but 28 per cent., and the rest of the time represented absolute idleness of the engine. These figures were obtained in actual service on an important road. Mr. Clark (C., B. & Q.) described a method of keeping track of the time service of locomotives, which, he believed, would accelerate locomotive movements through the roundhouse. Mr. Gaines had found it very advantageous to keep careful records of the movements of engines. This subject hardly received the attention which it seemed to merit.

SHOP LAYOUTS.—This excellent report was presented by Mr. C. A. Seley. This report included Mr. Soule's articles reprinted from the AMERICAN ENGINEER, and dealt with shop facilities, appliances, organization and personnel. It is a strong plea for a broad-minded treatment of the shop question, which makes for efficiency and adequacy in shops to meet the requirements of the times. It is the most important discussion of the subject we have seen—advocating new methods to meet the new needs. This report is worthy of an edition de luxe, to be placed on the desk of every railroad official in the country who has anything to do with actual operation. It is a powerful argument in favor of business methods in providing railroad shops.

Mr. F. F. Gaines spoke favorably of the idea of the large shop, and criticized prevailing methods of comparing output of shops on a unit basis without including a great deal of information not usually given, without which fair comparisons cannot be made. He also discussed the longitudinal *vs.* transverse shops. Professor Hibbard spoke of the personnel, and was glad to see the man question discussed as a shop question. He strongly approved the plan of the Baldwin Locomotive Works in establishing the office of superintendent of apprentices.

LOCOMOTIVE FRONT ENDS.—Mr. Vaughan expressed gratification at the generous response from the roads in supplying funds for finishing the study of the proper relation between stacks and nozzles. The previous work had been found valuable in practice. The question of diaphragms was the most important of the front end questions. It is desirable to design front ends which will be self-cleaning and at the same time interfere as little as possible with the draft.

The committee was continued, and the recommendation to the effect that the results be published in the AMERICAN ENGINEER was carried.

INDIVIDUAL PAPERS.

TECHNICAL EDUCATION OF RAILROAD EMPLOYEES, BY G. M. BASFORD.—This paper, while devoted to education, was really directed toward the questions of labor and organization. It brought out a remarkable discussion, which lasted an hour and a half. Mr. F. F. Gaines had found it necessary to "catch your hare before you cook it," the difficulty being to get the desirable young men. Mr. Tonge (M. & St. L.) pointed to the necessity for providing good foremen, in order to educate apprentices. He did not say how the foremen should be had or how they should be paid. Dr. Goss spoke of the opposition of the men toward apprenticeship, which he felt sure would be overcome, as the workman cannot object to the principle of training his own son. He spoke with admirable clearness and decision of the necessity for making apprenticeship attractive. Separate organizations for caring for apprentices had been found necessary in manufacturing establishments, and would probably be necessary also on railroads. Mr. W. D. Robb (Grand Trunk) described the apprentice system of that road with its 40 per cent. of apprentices. This interesting statement will be referred to again in this journal. Undoubtedly Mr. Robb's apprentice system is the most extensive on this continent. Mr. George West (N. Y., O. & W.) stated his opinion that the secret of success in an apprentice system was "foremen and fairness." Mr. J. F. Deems believed that boys were about the same as they were 40 years ago. He said "there is no question to-day confronting the railroads of this country that is so important in all its bearings and ramifications as this question of the proper education of the employees of the railroads." Mr. Parkes (Michigan Central) described the apprentice system of that road, and supported the arguments in favor of apprentice schools. Mr. J. F. Walsh (C. & O.) gave strong support to the paper, and specially to the contention in favor of placing all apprentices on the same level, whether technical school graduates or not. Mr. W. E. Symons wanted to see the apprentice, the foreman and the master mechanic properly paid. "A man will not endure years of hardship and privation" for such poorly paid positions. Mr. S. W. Miller (Pennsylvania Lines) made an excellent presentation of the question from the point of view of a successful master mechanic, who had been a special apprentice after completing a technical school course. He did not agree with the author of the paper as to the special apprentice, but said: "I do not believe that ten years, on the average, is any too long for a young man to serve as a special apprentice." The speaker showed the importance of knowing the men and getting "close to them" in the shop. Others added very valuable remarks to the discussion. The tone of the remarks indicated that great progress has been made in the attitude of railroad men toward the apprentice.

SUPERHEATED STEAM IN LOCOMOTIVES.—Mr. Vaughan briefly reviewed his admirable paper. He considered the Pielock as the most promising theoretically, but he doubted its success practically. As to results, he considered the fact that the superheater was shown to be "as good as a compound" to be very important. On 4 months' records the Schmidt superheater had saved 10 per cent. over the 2-cylinder compound and the Cole superheater had shown itself to be as good as the compound. Lubrication was mentioned as a most impor-

tant necessity in the use of superheaters. He believed it possible to use sight feed, displacement lubricators. It was not sufficient to oil the valves and expect the oil to go down to the cylinders. The cylinders must be oiled separately. The speaker believed it practicable to reduce boiler pressures to 175 lbs. in connection with superheating, thus gaining an amount in cost which would offset the extra cost of applying superheaters. The paper was received with hearty applause of appreciation. Later he said that he considered the superheater to stand about 10 per cent. better than a compound, basing this upon records varying considerably, but taken in actual service. Mr. Whyte expressed the opinion that if 10 per cent. on the total coal bill could be saved by the superheater which was in use only when the cylinders were using steam, the superheater furnished the best possible method of helping the fireman. The paper was so complete and satisfactory as to lead to no criticism and little discussion. Mr. Sauvage stated that Mr. Vaughan's paper and the data he had obtained in this country would lead him to be more eager to see superheating tested in France. Mr. Vaughan wound up the discussion by stating that the Canadian Pacific would soon have 106 superheater locomotives in service. He was prepared to believe that superheating offered a satisfactory reason for not using compounds. No matter what could be said in favor of compounds, it was generally understood that they had more engine failures than simple engines. He stated plainly that the superheater engines were the best on the road from the roundhouse standpoint.

TOPICAL DISCUSSIONS.

WATER SPACES AROUND FIREBOXES.—Mr. Lawford H. Fry presented a brief statement which appears in this issue on page 247. Mr. T. H. Curtis (L. & N.) referred to the breakage of staybolts, and stated his belief that there was an unknown law governing breakage, in which the boiler pressure was an important factor. In answer to a question, Mr. F. H. Clark spoke of ¾-in. staybolts, spaced 3 ins. apart, which were applied to a number of new engines, but no definite results had yet been obtained. Mr. Deems confirmed Mr. Fry's statement as to the desirability of placing the outer firebox sheet vertically in order to avoid conflict of the bubbles of steam from the inside sheet with down-coming cold water. Mr. A. E. Mitchell supported the idea of vertical outside sheets. Mr. Fry wanted to be understood as referring specially to fireboxes in which the sheets were approximately parallel. W. E. Symons believed that the character of the water decided questions of design of fireboxes. Dr. Goss believed it impossible to get the water spaces too wide at the mud ring, and that the spaces should widen as rapidly as possible above the mud ring. Mr. C. A. Seley stated that 4½-in. mud rings were adopted by the power committee of that road, the water spaces being the same width all around.

The topical discussion on relief and by pass valves resulted in ordering the subject referred to a committee to report next year; so also did the discussion on automatic locomotive stokers.

A resolution was passed thanking the contributors to the fund for the continuation of the AMERICAN ENGINEER tests.

A resolution was passed amending the constitution to provide for executive members in the same manner as provided in the constitution of the Master Car Builders' Association, which increases the number of officers by adding six executive members.

The attendance at the convention was unusually large, the number of members registered being 298. This year the exhibitors numbered 220, covering 40,000 sq. ft. with exhibits, not including passageways. Last year 187 exhibitors used 25,000 sq. ft. of space. The exhibits were well attended and carefully studied.

Messrs. Deems, A. W. Gibbs and A. E. Mitchell were appointed a committee to aid in inaugurating a master mechanics' dictionary, to be published by the *Railroad Gazette*.

The election of officers resulted as follows: President, H. F. Ball; first vice-president, J. F. Deems; second vice-president, William McIntosh; third vice-president, H. H. Vaughan; treasurer, Angus Sinclair; executive members—G. W. Wildin, C. A. Seley, A. E. Mitchell, A. E. Manchester, J. F. Walsh, F. H. Clark; secretary, J. W. Taylor.

The convention adjourned June 16 after very successful meetings, in which the discussions were exceedingly well conducted.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-NINTH ANNUAL CONVENTION.

This convention was called to order by the president, Mr. W. P. Appleyard. In speaking of the interchange rules, he hoped that the "golden rule" would continue to guide the association in governing the interchange of cars in the greatest nation in the world. There had been but 15 arbitration cases submitted to the arbitration committee during the year, and this indicated the satisfactory way in which the rules were working. This year a question of damage by flood was to be brought before the association. Electric traction and its probable effect upon the problems of the association was pointed out as a subject to be provided for. The steam railroad would soon have active competitors. The president spoke impressively of the necessity of educating the men who are to carry the responsibilities of the future. The paper on the subject of education of recruits, read by Mr. Basford before the Master Mechanics' Association, was recommended to the attention of the association. Japan's success in the present war constituted an example showing the importance of education and preparation. Among references to equipment matters more side-play to couplers was considered desirable, and all possible steps toward a standard coupler should be taken. The address was high-minded, thoughtful and polished, and it inspired the convention with a serious purpose in beginning its work. It established a tone for the convention which was sustained to the end.

The report of the secretary and treasurer showed a bank balance of $4,545.42. The total membership was stated to be 607.

A change in the constitution was proposed, having for its object an extension of the scope of eligibility for membership.

Mr. Edward A. Moseley, secretary of the Interstate Commerce Commission, addressed the association. His chief subject was the application and administration of the safety appliance law. The law had met with responses beyond the greatest expectations of those responsible for it. The number of cars found defective by the inspectors of the commission had been reduced in a remarkable manner, indicating the spirit of the roads in carrying out the law. The speaker expected soon to see the interchange rules practically the same as the law of the land. His remarks were very complimentary to the railroads.

COMMITTEE REPORTS.

TRIPLE VALVE TESTS.—Mr. McIntosh (C. R. R. of N. J.) presented the subject. The report was accepted and the recommendations adopted without discussion.

BRAKE SHOE TESTS.—Dr. Goss read the report in abstract. It was accepted without discussion.

REVISION OF STANDARDS.—Mr. C. A. Schreyer (C. & N. W.) presented the report. These concerned dust guard plates, journal box lids, wedges, brake heads and shoes, brake beams, coupler yokes and other details contemplating their improvement in important ways, but without radical changes. All but the proposal to increase the length of standard brake shoes were ordered referred to letter ballot. Mr. R. P. C. Sanderson (Seaboard Air Line) stated that he had recently learned that in New Zealand the rules of the M. C. B. Association were considered satisfactory evidence of good and safe practice before the law courts. This was advanced as a reason for hesitating to complicate the rules by changes not positively necessary.

Air Brake Hose.—This report recommended the specifications for hose which were proposed last year and the adoption of M. C. B. standard hose, providing for such hose in the interchange rules, which has never been done. The specifications were intended to provide a satisfactory quality without unnecesarily increasing expense. The report included records of tests at Purdue University, showing that a large quantity of poor hose is being used to-day. Providing for improved hose in the rules would compel its use in interchange. Mr. A. W. Gibbs (P. R. R.) thought that the committee ought to provide in the specifications for hose which is not wrapped—that is, woven hose. The report was referred to letter ballot.

Tests of M. C. B. Couplers.—This important report constituted a step toward a standard coupler. The report gave evidence of careful work and carefully considered conclusions. In the test of unit stresses on knuckle pins the present lack of uniformity was indicated by the variation between 41,000 and 85,000 lbs. per sq. in. in ultimate load. In the discussion Mr. Sanderson argued against the abolition of the slots in couplers, as this would cut out a certain promising development in draft gear. He wished to see recommendation No. 7 (by the committee) removed before the matter is referred to letter ballot. The report was referred to letter ballot in such form as to provide for retaining the key slot in coupler stems, but not to provide for continuous draft gear.

Truck Arch Bars.—The recommendations of this report were referred to letter ballot without discussion.

Safety Appliances.—This report was not printed in advance of the convention. It was considered too important for immediate action, and was referred to the committee on standards for report next year. No discussion.

Steam Line Connections.—This subject was referred to a committee to report a standard steam hose coupler next year.

Repairs of Steel Cars.—This report discussed the splicing of sills of steel cars when it is necessary to cut them within a distance of 8 ins. from the bolsters. The committee recommended splices, which were ordered referred to letter ballot.

Stenciling Freight Cars.—The recommendations were accepted by the association, to be presented later for letter ballot for adoption when the work of the committee is completed.

Interchange Rules.—The decisions of the arbitration committee in cases decided during the past year were approved as a whole by a unanimous vote. The established high standing of the work of the arbitration committee was sustained by the association by the adoption of all of the recommendations of the arbitration committee with respect to changes in the rules. In the matter of responsibility for damage to cars by flood when away from home a spirited discussion was held, resulting in sustaining the arbitration committee in its decision, ruling, in effect, that storm or flood does not relieve a railroad of responsibility for damage to borrowed cars. The interchange rules were completely disposed of in *one hour and fifteen minutes*, which is the best possible tribute to the work and influence of the arbitration committee.

Rules for Loading Long Materials.—This report illustrated the importance of the "get together" methods employed by this association. At the opening of the convention several interests were far apart in their opinions. By meetings and conferences these differences were adjusted, and the report of the committee after its amendment was referred to letter ballot for adoption.

Safety Chains.—This committee believed that better permanent safety chains could be devised, and presented suggestions for temporary chains for use on cars carrying double loads. The recommended chains were referred to letter ballot for adoption, the committee being continued for further report next year.

Loss of Cars in Floods.—This subject was brought up again by the executive committee in the form of a resolution to the effect that if the recent loss of cars in floods on roads running out of Kansas City was not made good to the owners in accordance with the decision of the arbitration committee, the roads refusing should be deprived of the benefits of the interchange rules and expelled from the association. Mr. W. E. Symons argued in defense of those roads, ably representing their interests. Mr. Seley of the Rock Island followed with objections against expelling these roads, calling attention to the action as probably being unconstitutional. Mr. Seley believed that the matter was beyond the authority of the association, and should be settled by the officers of the roads involved, and, if necessary, by legal recourse. Several speakers questioned the desirability of such a drastic measure as the passage of the resolution. Several favored further attempts at adjustment. Mr. Sanderson amended the resolution to remove the penalty, thus plainly expressing the position of the association in sustaining the arbitration committee, but removing the penalty clause—this established peace with honor, after a vigorous, tense debate.

Guarantee for Cast Iron Wheels.—This report presented the opinions of the wheel makers—a result of an effort to get the users and makers of wheels together in a general form of guarantee. The report was not printed in advance of the convention. The subject was referred to a standing committee on cast iron wheels, this committee to consider the complete contour of wheels, and to specially consider the possibility of increasing thickness of flanges.

Doors.—The recommendations of this report were referred to the executive committee.

TOPICAL DISCUSSIONS.

Service of Cast Iron Wheels.—The new M. C. B. wheels had not been in service long enough to establish conclusions, but those which had been in use had given a good account of themselves. It seemed probable that the association had not made a mistake. Mr. Fowler stated that many railroad officers doubted the advisability of using cast iron wheels at all under 100,000 lbs. capacity cars. He quoted tests showing pressures required to break off flanges of wheels. Stresses to which flanges of wheels are subjected were believed to constitute an important field for investigation by the association.

Greater Braking Power on Freight Cars.—Mr. F. M. Gilbert raised the question of how braking power could be increased without introducing undesirable complications. The speaker believed that train line pressures should be increased. There was no discussion.

Height of Couplers of Passenger Cars.—Mr. T. H. Curtis directed attention to the importance of straightening out the present wide variations in the height of couplers and platforms. A number of speakers expressed definite opinions as to the need of action by the association. It was ordered referred to a committee for report next year.

Riveting Yokes.—Introduced by Mr. William McIntosh, who explained the reasons why it is desirable to strengthen the attachment of yokes to couplers. Mr. Garstang thought that all holes in drawbar yokes and coupler stems should be drilled. Mr. Deems showed that coupler yoke attachments should be greatly improved by good fitting, in order to withstand the stresses produced by heavy engines. Mr. Hennessey referred to weakness in the coupler shanks, which were too thin at the ends. Mr. Fowler referred to the desirability of good fitting, which would permit of securing the full benefit of the lips at the ends of the shanks to relieve the rivets of strain. Mr. Hennessey stated very plainly that good fitting was not now being done. The size of rivets should be increased. "The poor inspector who tries to get good fitting at contract shops is up against a hard proposition." Mr. West said that the scrap pile was a great educator on this question, 90 per cent. of the breakages found were at the fastening. Mr. Garstang's motion was amended, and the matter was referred to the coupler committee for recommendation and specifications for future construction. Mr. Ball argued in favor of a flexible

attachment using a 2¼-in. pin in a knuckle joint, which he proposed last year and had used successfully in practice, believing that an attachment better than riveting should be considered. The subject was ordered referred to the coupler committee for report next year.

The following officers were elected: President, Joseph Buker; first vice-president, W. E. Fowler; second vice-president, G. N. Dow; third vice-president, R. F. McKenna; treasurer, John Kirby; executive members—H. M. Carson, G. W. Wildin, T. H. Curtis.

Mr. C. W. Martin, speaking for the supply men's organization, stated that, from their standpoint, this had been the "best convention" the association had ever held.

The association adjourned after a record-making convention of which the retiring president, Mr. W. P. Appleyard, should be proud.

NOTES OF THE CONVENTION.

Mr. Moseley, secretary of the Interstate Commerce Commission, upon request defined what the expression "going between cars" actually means. It now applies to actual coupling, and the law says that men shall not be obliged to go between cars at all. Strictly interpreted, this prohibition applies to the coupling of air hose, and the speaker referred to progress which is making in automatic devices for coupling air hose, indicating that the day will come when such devices would be generally used. Mr. Moseley emphasized the obligation of the railroads to see that the safety appliances of cars are in good order before accepting cars in interchange.

The importance of the interchange rules and the smoothness of their operation were indicated in conversation with a prominent master car builder. This gentleman said: "We have collected $261,000 from other roads for repairs to cars during the past year. Ninety per cent. of these transactions were conducted upon honor, without the slightest question or friction."

Indicating the extent of flange breakage, one speaker stated that on his road over 1,000 cases had been discovered in a single year.

A visitor familiar with railroad matters, who attended the M. C. B. Convention for the first time, remarked: "This is the most businesslike lot of able men I ever listened to. The earnest but good-humored way these people discuss important questions, where opinions differ, is a wonder." He undoubtedly referred to Mr. Schroyer's breezy manner of keeping everybody good-natured.

It would be difficult to find an organization of men whose discussions are as businesslike, direct and full of "meat" as those of this association at this convention. The discussions were models, which should be an example to other organizations of technical men.

100,000-POUND STEEL ORE CAR.

DULUTH, MISSABE & NORTHERN.

This is a short, strong car built by the Standard Steel Car Company specially for ore service on this road. It is built throughout of structural steel, with 15-in. channel center sills and 6-in., 10½-lb. channel side sills. The side stakes are of channels and angles. The light weight is 32,200 lbs.

In ore cars it is necessary to arrange the doors specially to suit the material. In this case four doors are operated in pairs, hung transversely across the openings and arranged to dump the load between the rails. This gives a large opening with a short wheel base. The doors are supported on their outer ends by chains passing over pulleys, the chains being operated by transverse shafts located under the hoppers at each end, and manipulated by the hand wheels shown in the photograph by means of gears and pinions. The air brake cylinder is hung from the lower face of one of the side sills, the releasing spring being placed on an outer extension of the piston rod. These cars are equipped with Westinghouse brakes, Simplex bolsters, Symington & McCord journal boxes, and Susemihl side bearings and Westinghouse friction draft rigging. The leading dimensions are as follows:

100,000-POUND STEEL ORE CAR—DULUTH, MISSABE & NORTHERN RAILWAY.

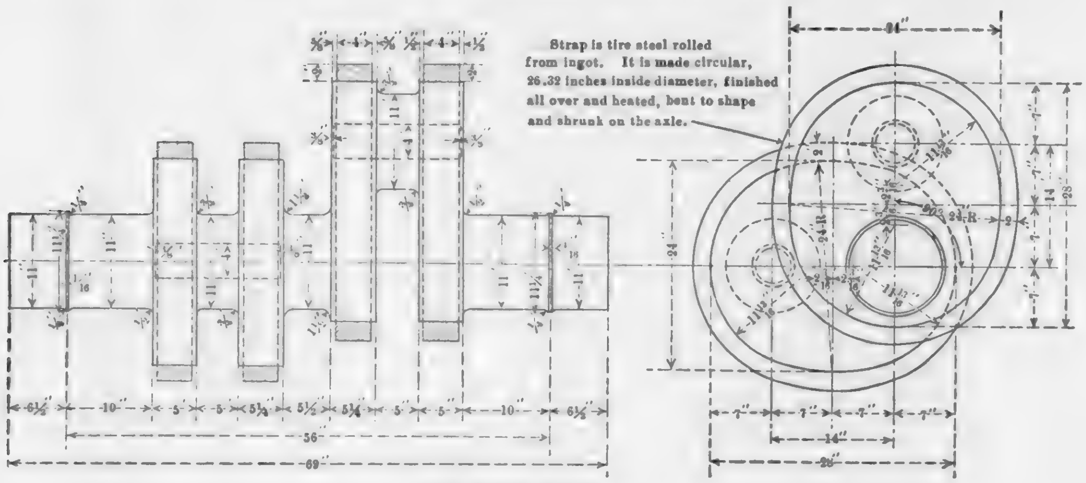
Length over end sills	22 ft.	0 ins.
Length of care inside of body	20 ft.	7 ins.
Width of car over side stakes	8 ft.	6 ins.
Width of car inside of body	7 ft.	11⅝ ins.
Height from top of rail to top of body	9 ft.	0 ins.
Height from top of rail to top of brake mast	9 ft.	6½ ins.
Length of drop doors in clear	6 ft.	8 ins.
Width of drop doors in clear	3 ft.	6 ins.
Height from top of rail to center of coupler	2 ft.	10½ ins.
Distance from center to center of trucks	13 ft.	6 ins.

MAINTAINING 10,000 LOCOMOTIVES.—There are 12 railroads entering Buffalo. These 12 roads own and operate 10,000 locomotives. The boilers of these locomotives contain about 19,000,000 rivets, 3,000,000 tubes, 13,000,000 staybolts, radial and crown stays.—*F. W. Williams, before Master Boilermakers' Association.*

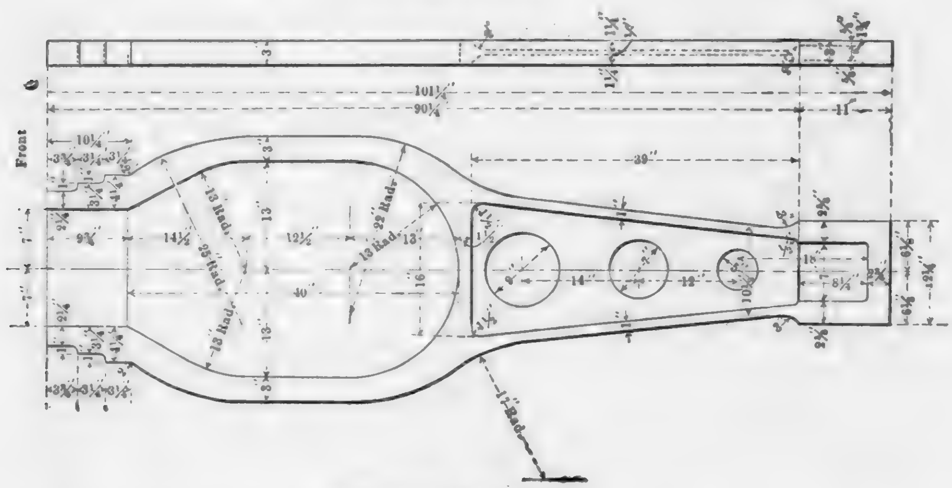
Mr. George L. Wall has resigned as assistant engineer of motive power of the Pennsylvania Company at Fort Wayne, Ind., to become mechanical engineer of the Lima Locomotive Machine Company, Lima, Ohio.

Mr. Charles M. Hoffman, road foreman of engines of the Burlington at St. Joseph, Mo., has been appointed master mechanic of the Southern Railway, with headquarters at Princeton Ind. He has been in the service of the Burlington since July 1st, 1887.

PACIFIC TYPE, FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—OREGON RAILWAY & NAVIGATION COMPANY.
BALDWIN LOCOMOTIVE WORKS, *Builders.*



THE CRANK AXLE.



BIFURCATED MAIN ROD.

4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE, PACIFIC TYPE.

OREGON RAILROAD & NAVIGATION COMPANY.

In this locomotive, built by the Baldwin Locomotive Works for the Oregon Railroad & Navigation Company, the Vauclain 4-cylinder compound arrangement was applied to a 6-coupled engine, being the first use in this country of the balanced principle in a locomotive of more than four coupled wheels. The cylinders are all in line, the intermediate axle is the crank axle and the high pressure cylinders are coupled to it by means of bifurcated main rods. This is an exceedingly important design, because if its expected success is attained it will open the way for the balanced compound principle for the heaviest passenger service, and it will show one way to accomplish this result.

This is a very heavy locomotive, weighing 231,300 lbs., which is 800 lbs. more than the Erie Pacific type locomotive, illustrated in May, page 172. In fact this new locomotive is the heaviest of its type and is the heaviest in passenger service except the Class K of the Lake Shore, which weighs 233,000 lbs. (See AMERICAN ENGINEER, 1904, page 413.)

The construction of this new locomotive as to details is, as far as practicable, similar to the adopted standards of the Harriman Lines, as outlined in May, page 154. The tractive power is 28,300 lbs., and the locomotive is equivalent when running as a compound to a simple engine with 24 4-10-in. cylinders. In starting it is equivalent to a simple engine with 22.4-in. cylinders.

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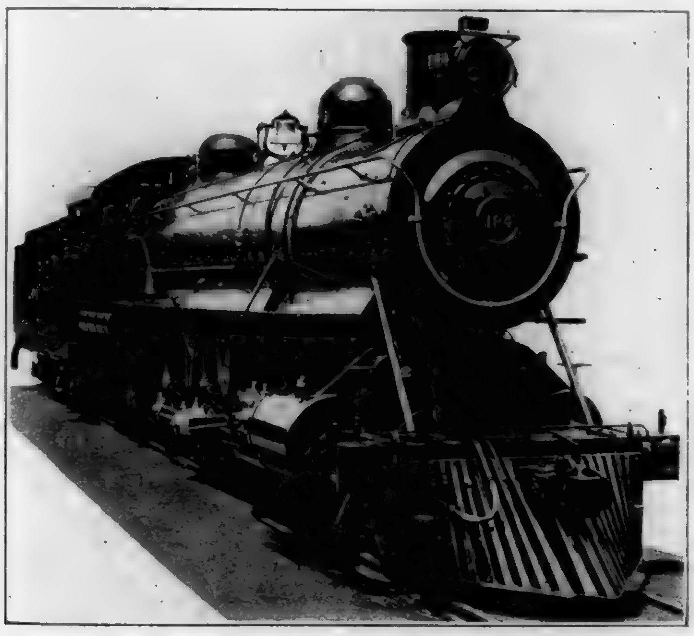
The crank axle is similar to that of the Burlington balanced locomotive by these builders, illustrated in June, 1904, page 213, with slight changes in dimensions.

The photograph showing the side view illustrates the new standard tender for passenger equipment on the Harriman Lines, having a capacity of 9,000 gallons of water and 10 tons of coal. The tender and the cab will be referred to in connection with the further description of the Harriman common standards. A list of dimensions follows.

PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE, OREGON RAILROAD & NAVIGATION COMPANY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal
Tractive Power	28,300 lbs.
Weight in working order	231,300 lbs.
Weight on drivers	143,600 lbs.
Weight on leading truck	43,400 lbs.
Weight on trailing truck	44,300 lbs.
Weight of engine and tender in working order	390,000 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel, base, total	33 ft. 7 ins.
Wheel base, engine and tender	64 ft. 1¼ ins.



PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE.

RATIOS.

Tractive weight ÷ tractive effort	5.07
Tractive effort x diam. drivers ÷ heating surface	713
Heating surface ÷ grate area	61.7
Total weight ÷ tractive effort	8.17

CYLINDERS.

Kind	Compound
Diameter and stroke	17 and 28 by 28 ins.

VALVES.

Kind	Piston

WHEELS.

Driving, diameter over tires	77 ins.
Driving, thickness of tires	3¼ ins.
Driving journals, main, diameter and length	11 by 10 ins.
Driving journals, front and back	9 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 10 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 12 ins.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108 by 66 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	245, 2¼ ins.
Tubes, gauge and length	0.125 m.m.; 20 ft.
Heating surface, tubes	2,874 sq. ft.
Heating surface, firebox	179 sq. ft.
Heating surface, total	3,055 sq. ft.
Grate area	49.5 sq. ft.

TENDER.

Frame	Steel
Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	9,000 gals.
Coal capacity	10 tons.
Weight of tender loaded, about	159,000 lbs.

WATER SPACES AROUND FIRE BOXES.

TOPICAL DISCUSSION BEFORE MASTER MECHANICS' ASSOCIATION.

BY L. H. FRY.

The question for discussion is: The best known dimensions for water spaces around fire box to produce minimum consumption of fuel and replacement of fire box sheets and reasons for same.

In endeavoring to discover what is known on this subject I made an examination of the water space dimensions of some 84 modern boilers. This investigation showed that there is no generally recognizable rule connecting the size of the water space with the fire box dimensions, but that there is an increasing tendency to use wider water spaces. So many reasons for the use of wide water spaces can be brought forward that it appears strange that the width has not been increased more rapidly. When the fire boxes were restricted in width by being placed between the wheels, the necessity of obtaining all possible grate area made it desirable to keep down the width of the water spaces to a minimum. Now, however, with the wide fire boxes above the wheels, there is but little excuse for reproducing these cramped water spaces. A free increase in the width of the water space around the fire box increases somewhat the dead weight of the engine, but the advantages to be gained will undoubtedly more than offset this.

I do not know of any experiments which will show the influence of the width of the water space on the evaporation, but it is obvious that a free circulation of the water will be ensured by wide water legs and will help the evaporative power of the fire box heating surface. In addition to the size of the water spaces, their shape has considerable influence on the evaporation and life of the fire box.

As the water in contact with the side sheets is turned into steam it must be allowed to rise to the steam space and must be replaced by other waters. The water spaces should be so designed that this natural circulation is aided, and that the currents of steam and water impede each other as little as possible. This is secured if the fire box side sheets are vertical or with a slight slope outward as they rise from the mud ring, so that the steam can rise along the fire box sheets and the water descend along the outside steel sheets without mutual interference.

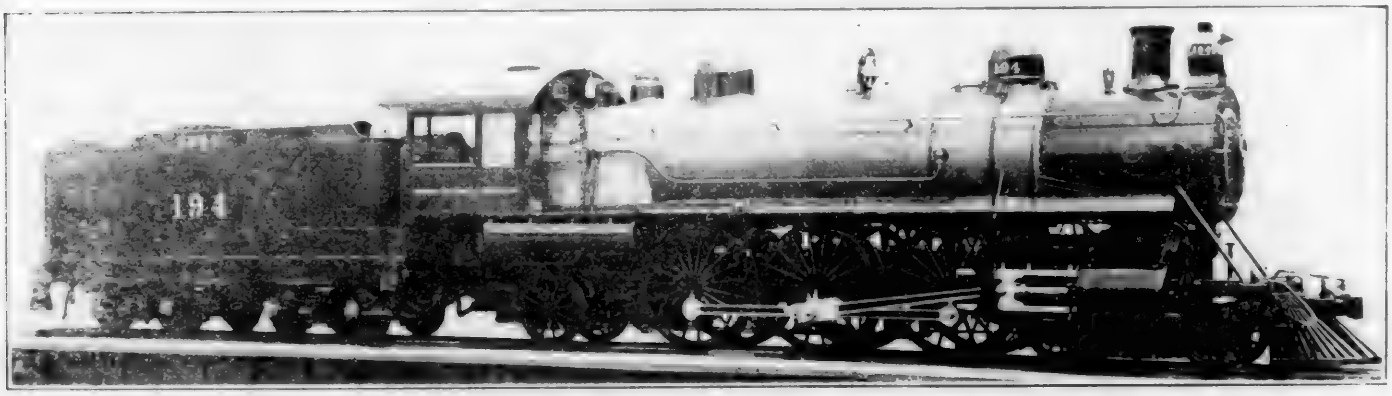
If, on the other hand, the fire box sheets slope inward in rising from the mud ring, the steam will tend to rise from the side sheets through the water space and along the outer sheets to the surface, thus interfering with the descending water current.

The side sheets, being subject to the full effect of the fire, require an active supply of water to allow the vigorous evaporation to proceed properly. If the water spaces are cramped or badly arranged, so that the water supply is not kept up, the water will fail to reach large areas of the side sheets, with results very detrimental to the life of the fire box sheets and staybolts.

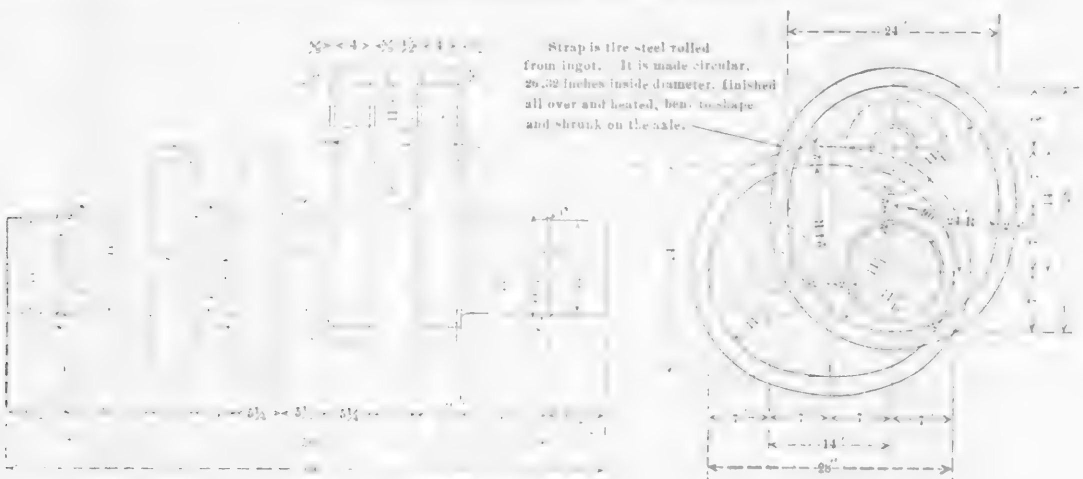
In one case of this sort we found on a certain lot of locomotives that there was a well defined oval space on each side sheet in which it was impossible to keep the staybolts tight until the cause of the trouble was removed by redesigning the water space to give the water free access to the side sheets.

Another advantage obtained by the widening of the water spaces is the increased flexibility and endurance of the staybolts. Some tests recently made on the B. L. W. vibratory staybolt testing machine show the advantage which can be expected from this source. Nine test pieces were cut from the same bar and vibrated with a deflection of 3-32 inch each side of the center while under a load of 4,000 pounds. All conditions were the same except the length of the test piece vibrated. Three bars were 8 inches, three 6½ inches and the remaining three were 5 inches in length. The average number of vibrations before fracture was 1,620 for the 8-inch, 960 for the 6½-inch and 695 for the 5-inch bolts. An increase of 60 per cent. in length of the bolt added more than 130 per cent. to its life when vibrated.

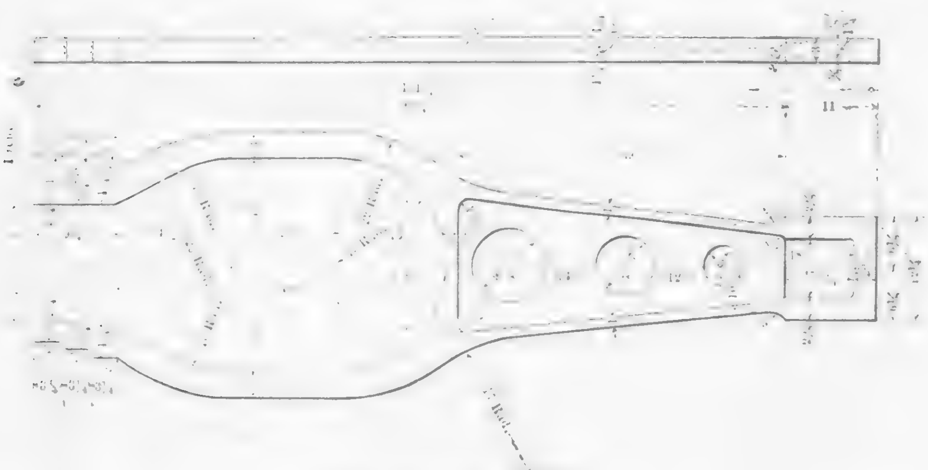
It appears that the rule for the best width of fire box water space is very much like Mr. Forney's rule for the size of a locomotive boiler, which is, make it as large as the other conditions permit. The figures obtained show a wide variation in practice. Among the wide fire box engines the narrowest water space measured as follows: Front leg, 4 inches at mud ring and 5 inches at throat; side and back legs, 3 inches at ring and 4 inches at crown. The widest space had a front leg measuring 5 inches top and bottom; side legs, 5 inches at ring and 6 inches at crown; back leg, 5 inches at ring and 7½ inches at crown.



PACIFIC TYPE, FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—OREGON RAILWAY & NAVIGATION COMPANY.
BALDWIN LOCOMOTIVE WORKS, *Builders.*



THE CRANK AXLE.



BIFURCATED MAIN ROD.

4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE, PACIFIC TYPE.

OREGON RAILROAD & NAVIGATION COMPANY.

In this locomotive, built by the Baldwin Locomotive Works for the Oregon Railroad & Navigation Company, the Vauclain 4-cylinder compound arrangement was applied to a 6-coupled engine, being the first use in this country of the balanced principle in a locomotive of more than four coupled wheels. The cylinders are all in line, the intermediate axle is the crank axle and the high pressure cylinders are coupled to it by means of bifurcated main rods. This is an exceedingly important design, because if its expected success is attained it will open the way for the balanced compound principle for the heaviest passenger service, and it will show one way to accomplish this result.

This is a very heavy locomotive, weighing 231,300 lbs., which is 800 lbs. more than the Erie Pacific type locomotive, illustrated in May, page 172. In fact this new locomotive is the heaviest of its type and is the heaviest in passenger service except the Class K of the Lake Shore, which weighs 233,000 lbs. (See AMERICAN ENGINEER, 1904, page 413.)

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Special attention is directed to the bifurcated rod, which is an element of boldness in design. This rod has been very carefully worked out, and it was made from a billet weighing about 4,000 lbs., the finished rod weighing 1,098 lbs. complete. It is understood that 45 carbon steel was used. The design of the rod is clearly shown in the engraving

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The crank axle is similar to that of the Burlington balanced locomotive by these builders, illustrated in June, 1904, page 213, with slight changes in dimensions.

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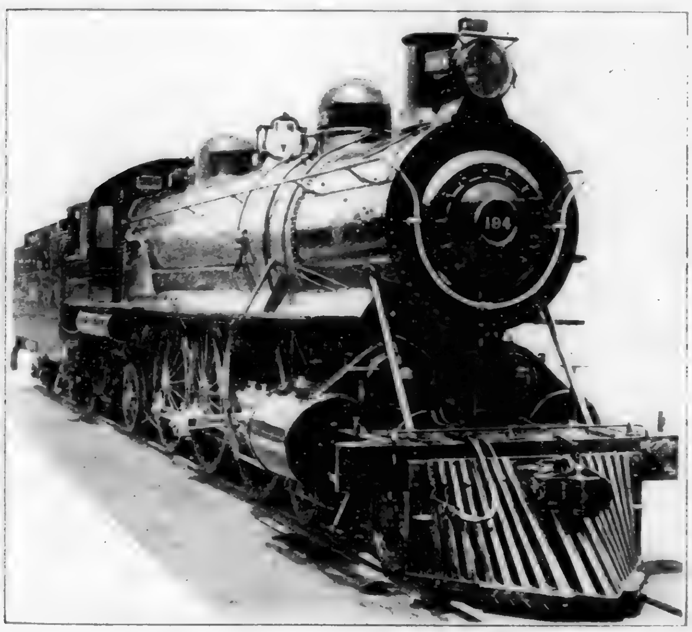
GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal
Tractive Power	28,300 lbs.
Weight in working order	231,300 lbs.
Weight on drivers	143,600 lbs.
Weight on leading truck	43,400 lbs.
Weight on trailing truck	44,300 lbs.
Weight of engine and tender in working order	390,000 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel. base, total	33 ft. 7 ins.
Wheel base, engine and tender	64 ft. 1½ ins.



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RATIOS.

Tractive weight ÷ tractive effort	5.07
Tractive effort x diam. drivers ÷ heating surface	713
Heating surface ÷ grate area	61.7
Total weight ÷ tractive effort	8.17

CYLINDERS.

Kind	Compound
Diameter and stroke	17 and 28 by 28 ins.

VALVES.

Kind	Piston

WHEELS.

Driving, diameter over tires	77 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	11 by 10 ins.
Driving journals, front and back	9 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 10 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 12 ins.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	70 ins
Firebox, length and width	108 by 66 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	245, 2¼ ins.
Tubes, gauge and length	0.125 m.m.; 20 ft.
Heating surface, tubes	2,874 sq. ft.
Heating surface, firebox	179 sq ft
Heating surface, total	3,055 sq. ft.
Grate area	49.5 sq. ft.

TENDER.

Frame	Steel
Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	9,000 gals.
Coal capacity	10 tons.
Weight of tender loaded, about	150,000 lbs

WATER SPACES AROUND FIRE BOXES.

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STEEL PASSENGER CARS.

UNDERGROUND ELECTRIC RAILWAYS, LONDON.

These cars were designed to meet all but impossible conditions, one of which was that the floor should be but 22 ins. above the rails. They are of steel and fireproofed wood. The Berwick Works of the American Car & Foundry Company have built 108 of them, 36 motor cars and 72 trailers, for the London Underground, known as the Yerkes system. One of the motor cars is illustrated. The motor cars seat 46 and the trailers 52 people. Both ends of the trailers are alike with what may be called submerged trucks, while the motor trucks are made more accessible by offsetting the floor over them and raising this part of the floor forming a compartment reached by a flight of three steps. This compartment provides for all of the electric apparatus except that which is attached to the trucks, as there is absolutely no room under the floor of the cars for resistances or anything else. The cars are built complete in this country and erected in temporary shops in Manchester, England. They are to be delivered on an incline in London entering the "Underground."

STEEL PASSENGER CAR—LONDON UNDERGROUND RAILWAYS.

STEEL CARS FOR LONDON UNDERGROUND RAILWAY.

	Motor Cars.	Trailer Cars.
Seating capacity	46	52
Length over car body	42 ft. 9⅝ ins.	41 ft. 11¾ ins.
Length inside passenger compartment	34 ft. 9¼ ins.	41 ft. 2½ ins.
Length inside motor room	7 ft. 7 ins.	
Length over buffers	50 ft. 0¼ ins.	50 ft. 2 ins.
Length over end sills	49 ft. 1½ ins.	49 ft. 1½ ins.
Width inside	8 ft. 1¼ ins.	8 ft. 1¼ ins.
Width over side sills	8 ft. 0 ins.	8 ft. 0 ins.
Width over belt rail	8 ft. 9¼ ins.	8 ft. 9¼ ins.
Width over all	8 ft. 10¾ ins.	8 ft. 10¾ ins.
Width at eaves	8 ft. 2 ins.	8 ft. 2 ins.
Height from rail to top of floor	0 ft. 22 ins.	0 ft. 22 ins.
Height from rail to top of floor in motor room	3 ft. 6⅛ ins.	
Height from rail to top of roof	9 ft. 5½ ins.	9 ft. 5½ ins.
Truck centers	33 ft. 0 ins.	33 ft. 0 ins.
Diameter of wheels	36 and 30 ins.	0 ft. 30 ins.
Weight of body	28,000 lbs.	25,000 lbs.
Weight of trucks without motors	17,350 lbs.	13,000 lbs.
Total weight exclusive of electrical equipment	45,350 lbs.	38,000 lbs.

Interesting details of the framing and construction must be reserved until later, the design being specially interesting because of its possible influence upon future passenger equipment construction. One of the motor cars when tested with a load of 105 men and 5,000 lbs. of pig iron in the motor compartment and 500 lbs. on the platforms, deflected a scant 1-16 in. at the center of the sides. The seats are both transverse and longitudinal, the frames being of steel and the seat backs are utilized as a part of the framing.

The cars are 50 ft. 1 in. long over buffers, 49 ft. 1½ in. long over platforms, 8 ft. ¼ in. wide over the sheathing at the sides, 8 ft. 9¼ ins. wide at the belt rails and 9 ft. 5⅛ ins. high from the rail to the top of the roof. The only straight lines in their construction are the floor, the windows and the longitudinal lines of the roof.

The floor is of cement and of course fireproof, with wooden strips, laid over a ¼-in. plate, in fact the car is thoroughly fireproof throughout. The interior finish is of mahogany and the roof of composite board covered with canvas. The interior panels are of Uralite and Transite. Dahlstrom metallic doors are used between the motor compartment and the body of the motor car and the mouldings are of the same material. The seat frames are of steel built into the car and the covering is fireproofed rattan. The motor cab is entirely of steel, including the roof. These cars are mounted upon 30-in. wheels for the trailer trucks and 36-in. wheels for the motor trucks. All of the wheels and axles are of Krupp manufacture. The trucks are of the standard construction adopted by the road, with cast steel frames. The sharpest curves on the line are of 150 ft. radius.

All of the electrical equipment was furnished by the British-Thompson-Houston Company. Other interesting details will be presented later.

In a list of 42 designs of suburban cars for railroads in the United States given by Mr. A. W. Sullivan in his recent paper before the International Railway Congress, the average weight per seat was 942 lbs., the lightest weight per seat being 688 lbs. (for 56-ft. cars carrying 72 passengers on the Chicago & Eastern Illinois). The weight per seat of the London Underground trailer cars is 731 lbs. The heaviest weight per seat in Mr. Sullivan's list is 1,365 lbs., in cars for the Cincinnati, New Orleans & Texas Pacific. In view of the fact that closed trolley cars with longitudinal seats weigh from 600 to 700 lbs. per passenger, the light weight of the steel cars of the London Underground is impressive.

TOPICAL DISCUSSION, MASTER MECHANICS' ASSOCIATION.

ARE SELF-CLEANING FRONT ENDS SATISFACTORY?—Opened by E. W. Pratt.

On the Chicago & Northwestern Railway we think the self-cleaning front end is satisfactory. All our larger classes of power are so equipped, and many locomotives with cylinders as small as 17 and 18 ins.

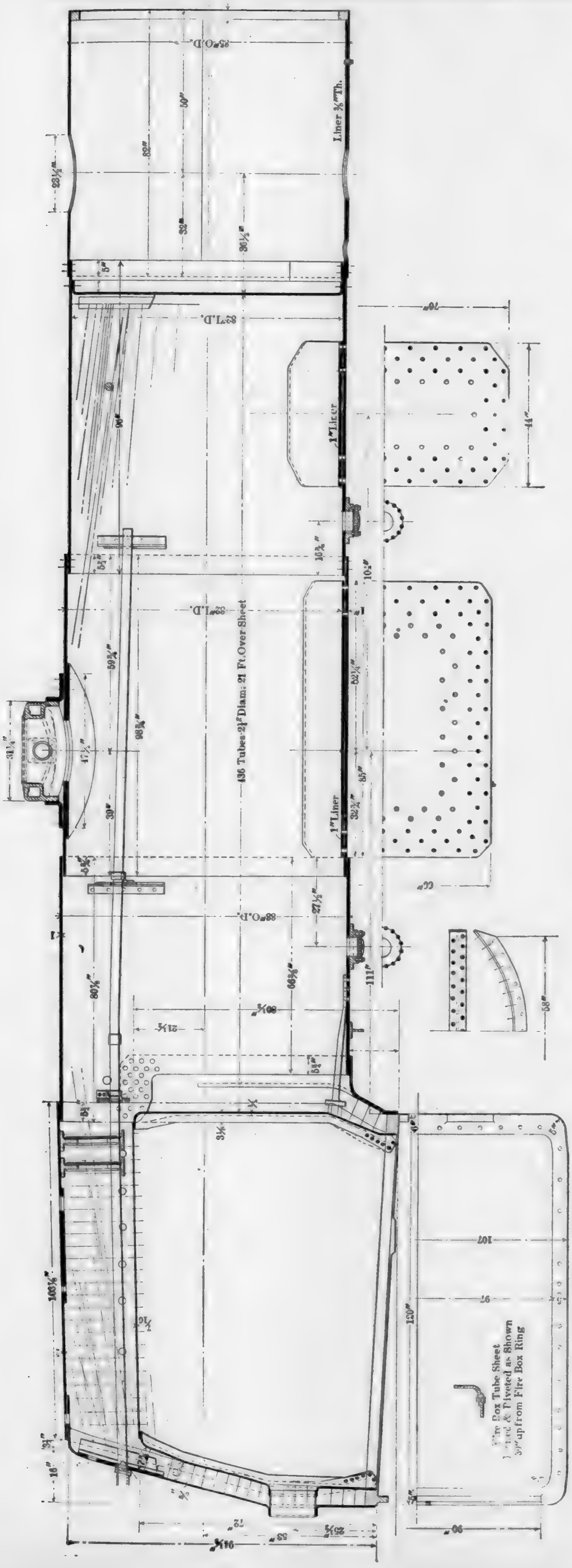
Out of 1,307 locomotives, over 600 have self-cleaning front ends. By comparing two years before and after making this change we find the amount of coal per 1,000 ton-miles decreased nearly 3 per cent., which I state merely to indicate that the self-cleaning feature has not increased the fuel consumption.

Delays on the road due to dumping cinders from the old style front ends are, of course, entirely eliminated, also the setting fire to engine truck packing from hot front end cinders.

There being no cinders to burn, the change has done away with burned and warped front end frames and doors, particularly where pressed steel shapes are used.

In changing the style of front ends we have not shortened up the extended front, which we believe would be of advantage in the way of obtaining better draft with still larger exhaust nozzles.

We wash out all boilers through the front flue sheet, hence the location of the apron extension of the deflector plate is important, hence I submit blue prints showing the moving of this apron from behind the exhaust pipe to a point in front of the same with hinge arrangement for adjustment and for throwing it entirely out of the way when washing out.

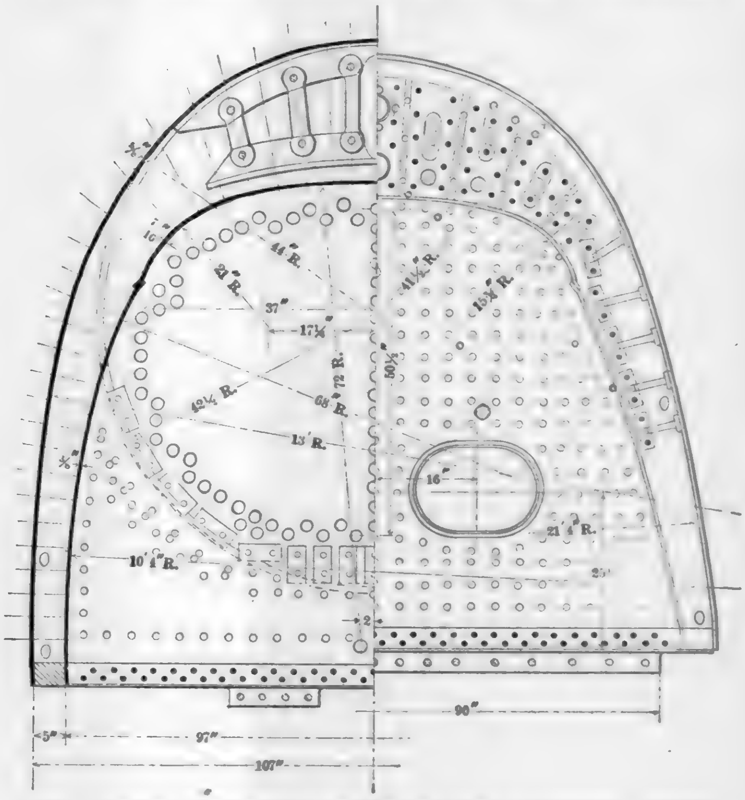


THE LARGEST LOCOMOTIVE BOILER.

MALLET ARTICULATED COMPOUND—BALTIMORE & OHIO RAILROAD.

The boiler of the remarkable Mallet compound locomotive, built by the American Locomotive Company for the Baltimore & Ohio Railroad, was illustrated from a photograph in May, 1904, page 167, and was again referred to in the general description in June last, page 237. The performance of this locomotive was described by Mr. Muhlfeld in our June number, 1905, page 229.

This boiler has a straight top and is 84 ins. in diameter outside the first ring, while the largest ring has a diameter of 88 ins. The firebox is 108 ins. long by 96 ins. wide, and the depth is 80 ins. in front and 72 ins. at the back. Water spaces of 6 ins. in front and 5 ins. at the back and sides are provided. There are 436 2¼-in. tubes, 21 ft. long, the tubes being No. 11 gauge. The heating surface is: Tubes, 5,366 sq. ft.; firebox, 219 sq. ft., making a total of 5,585 sq. ft., which is the largest



THE LARGEST LOCOMOTIVE BOILER—MALLET COMPOUND LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.

ever employed in a locomotive boiler. The grate area is 72 sq. ft.

This boiler has thick plates. Those of the shell are 1 in. thick, the roof is ⅝-in., the front tube sheet ¾-in., the back head ⅞-in., and the throat sheet 1-in. The back tube sheet is ½-in. and the other firebox sheets 7/16-in. The boiler is 38 ft. 5 ins. long from the front end to the firebox door. It weighs, empty, and without tubes, 57,000 lbs., and complete, with water, 117,000 lbs. The water alone weighs 33,000 lbs., and the tubes alone, 27,000 lbs.

The drawing shows a large liner plate 1 in. thick on the inside of the bottom part of the shell at about the middle of its length. This is for the attachment of the saddle for the high-pressure cylinders. While this is an enormous boiler for an enormous locomotive, it is said to be easily fired by one man, but it is difficult to believe that one man can properly fire it in a pull of any considerable length. Here is certainly a fair field for the automatic stoker people to show what they can do.

As shown in the engraving, the throttle pipe connections are made at the sides of the dome, the passages to the throttle being cored in the cast-steel dome. The boiler has two firedoor openings, which are fitted with sliding doors. The injectors are on the back head and discharge through pipes leading well forward into the first shell course of the boiler. The center of

the boiler is 10 ft. above the tops of the rails, this being the greatest height of boiler in our record.

DIMENSIONS OF THE LARGEST LOCOMOTIVE BOILER.

Working pressure	235 lbs. per sq. in.
Diameter outside the first course	84 ins.
Distance between tube plates	20 ft. 10¾ ins.
Thickness of barrel and saddle sheets	1 in.
Thickness of tube sheet	⅝ in.
Thickness of outside firebox and back lead	⅝ in.
Number of tubes	436
Diameter of tubes	2¼ ins.
Height of boiler centre above rail	10 ft.
Height of stack above rail	15 ft.
Firebox length (inside)	108⅛ ins.
Width (inside)	96¼ ins.
Thickness of tube sheet	½ in.
Thickness of crown sheet	7-16 in.
Thickness of side sheets	⅜ in.
Thickness of back sheet	⅜ in.
Grate area	72.2 sq. ft.
Heating surface, firebox	219 sq. ft.
Heating surface, tubes	5,366 sq. ft.
Heating surface, total	5,585 sq. ft.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

III.

(For previous articles see pages 154 and 200.)

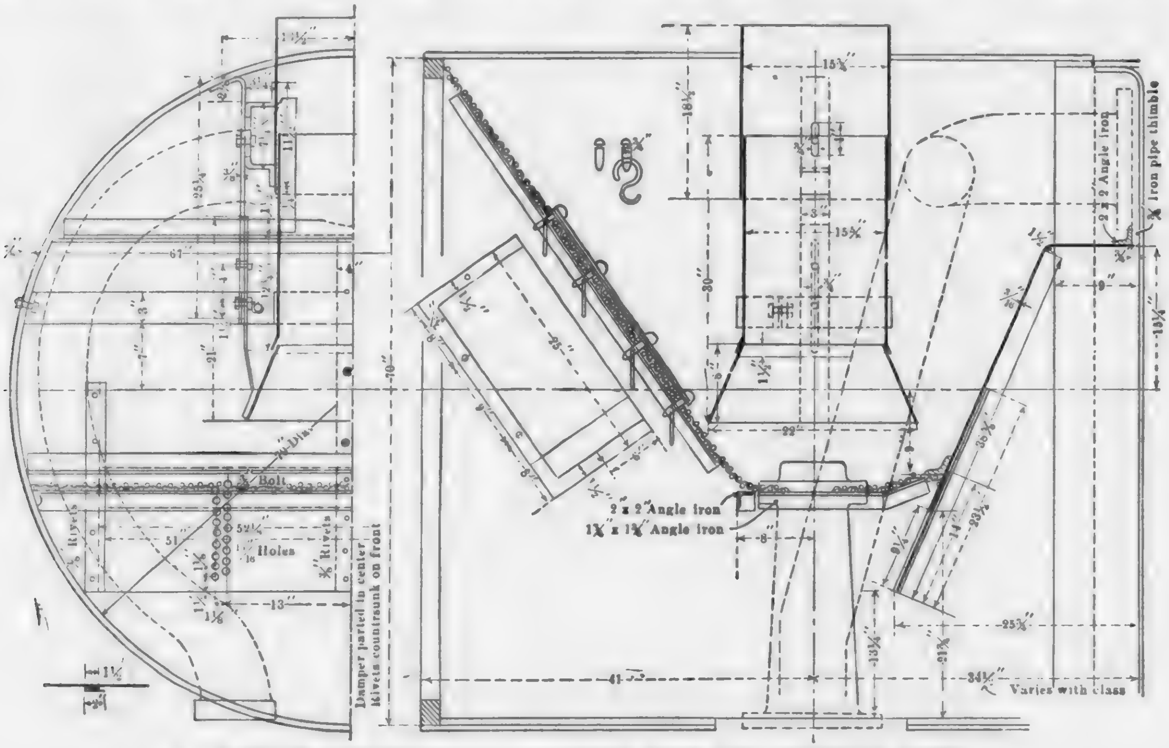
SMOKE BOX ARRANGEMENT.

As given on page 154 of the May number of this journal, the boiler diameters of the four types of standard locomotives are 70 ins. for the Atlantic, Pacific and switching locomotives and 80 ins. for the heavy consolidations. The smoke boxes are all sufficiently long to provide for cinder pockets in front of the cylinders and in fact all of the standard engines are fitted with them. The lengths of the smoke box rings are as follows: Atlantic, 71¼ ins.; Pacific, 91 9-16 ins.; consolidation, 69 9-16 ins.; switcher, 57½ ins. These will be illustrated later in connection with the boilers.

The arrangement of the smoke boxes is the same for all engines except as modified by the two diameters of boilers, the boiler of the consolidation type being larger than the others.

The same exhaust nozzle casting is used for all engines and the same size petticoat pipe with a 22-in. flare at the bottom. The diaphragm plate varies in size between the 70 and 80-in. boilers, but is arranged in the same way in both. This also applies to the netting. The distance between the center of the exhaust pipe and the front ring of the smoke box of the Atlantic and Pacific types is 41 ins., this distance on the consolidation is 46 ins. and on the switcher 38 ins. The distance from the center of the exhaust pipe and the front tube sheet varies necessarily in the different classes. It will be noticed that these petticoat pipes are all made in a single piece and are 15¾ ins. inside diameter.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD ARRANGEMENT OF LOCOMOTIVE FRONT END—HARRIMAN LINES.

AMERICAN LOCOMOTIVE COMPANY TO BUILD AUTOMOBILES.—This company will build a plant at Providence, R. I., adjacent to the Rhode Island Locomotive Works, where, under the supervision of Mr. Haughton, the Berliet automobile is to be built, the American Locomotive Company having secured the exclusive right to manufacture these machines in this country. The initial output will be about 200 cars; the first machines to be 40 and 20 h.p. It is likely that the construction of automobile trucks for heavy service will follow.

ELECTRIC VS. STEAM TRACTION.—Mr. L. B. Stillwell, at a recent Institute traction dinner, said in regard to the Manhattan Elevated system: "Electrification of the elevated lines in New York has increased their capacity by one-third, and has decreased by one-fifth the time spent on trains by the average passenger. It has been demonstrated that the cost of maintenance of electrical equipment of rolling stock is materially less than steam equipment. It has proved that electricity can render more reliable service than steam, the aggregate delays due to all causes on the Manhattan lines now being less than one-half per car mile what they were when steam was used as a motive power.

RAILROAD MILEAGE OF THE WORLD.—According to figures printed in the *Archiv fur Eisenbahnwesen*, the total railroad mileage of the world at the end of the year 1903 was 531,659 miles. Europe has 186,566; Asia, 46,293; Africa, 15,549; Australia, 16,595, and America (North and South) has 268,655 miles.

COAL MINED IN 1904.—The production of coal in the United States in the year 1904 amounted to 351,196,953 tons of 2,000 lbs., of which 73,156,709 tons were Pennsylvania anthracite. During the past four years the amount of coal reclaimed annually from the culm banks by washing has amounted to about 2,500,000 tons.

MASTER MECHANICS' ASSOCIATION.

(*Other papers and abstracts of reports appear on page 271.*)

THE MECHANICAL STOKER—Opened by William Garstang.

The question of a scientific method of firing locomotive engines is not of recent origin. It has always been uppermost in the minds of the management of railways, as is evidenced by the fact that some companies have offered prizes of various kinds for the most efficient and economical firing, and this, too, in the day of the small engine, whose grate area did not exceed 30 sq. ft., with a maximum steam pressure of 180 lbs. If it was a question then, how much more important it must be to-day with 50 sq. ft. of grate area and a steam pressure of 200 lbs. or more.

Two hundred pounds of coal is an enormous quantity to burn per square foot of grate in an hour, but it can be done, and this would mean that with a grate having 30 sq. ft. of surface, the consumption of 3 tons an hour. This implies a shovel of coal every ten seconds, and we believe this is as much as the ordinary man can do. If we obtain, by compounding or superheating, more steam from 3 tons of coal, we have increased the capacity of the fireman, but who can say how long it will be before we must further increase the size of our engines and consequently the capacity of the fireman, the latter now admitted to be up to the limit.

Ten years ago the most of us thought the maximum size of locomotives had been reached, when a spurt followed and the locomotive grew rapidly. Has the limit yet been reached? The engine having grown to such proportions in the past ten years, it is pertinent to ask, has the fireman also grown in that time? Experience says "No." An engine with 50 sq. ft. of grate surface, burning 200 lbs. per hour per square foot, will consume 5 tons per hour, and if you get a fireman with sufficient physical endurance to handle 5 tons of coal per hour on an engine scheduled 45 (or 50) miles per hour, as they are to-day, he will very likely fall below the requisite in brain power, and, of course, be an inefficient fireman. This we all know from experience. So it seems our engines have passed the limit of human endurance in the matter of efficient firing.

A young man thinks he would like to fire a locomotive; he makes application for the job; he goes with the foreman to look over an engine, and the enormous size of the boiler fills him with dismay, and he goes into some other business. This means that the work on the big engines is more of brawn that of brain. Some will say: "That is all you need for a fireman." But where are our engineers to come from? Surely they must be men of "head," now more than ever, when speeds are high and trains are heavy. This employment of "coal heavers" for the left-hand side of the engine will surely be felt before long on the right-hand side, when promotions must be made.

They say: "Necessity is the mother of invention." It seems to have been so in this case. I presume some one, seeing farther ahead than most of us, thought: "Why won't an automatic stoker work as well on a locomotive as on a stationary boiler?" To think was to act, and we now have a practical mechanical fireman that is going to revolutionize the grade of men who enter the firing service and eventually become engineers. Instead of the "horny-handed son of toil," with a back like a horse, who must work like a coal heaver for ten or twelve hours continuously, we will have a set of men of greater intelligence—men whose heads will guide the stoker and control it—men who will not sit idly in the engine cab by any means, but who, though busy, will not be continually "frizzled" back of the open fire door, with their eyes blinded so that signals cannot be properly interpreted; but who, through intelligent operation of the stoker and careful watchfulness of the track and signals, and who coming in from a trip are not so tired out that they cannot study the rules and regulations and prepare themselves for advancement, will make a high grade of locomotive engineers when advanced to that position, and which will gradually mean a continuous elevation of both the men and the service.

Now, as to the stoker in actual service. It has been four years since the first mechanical stoker was tested on a Big Four engine. About six months ago we installed a mechanical stoker known as the "Victor," and same as the one on exhibition at the convention, on seven of the largest passenger engines on our system. Four of these engines have wide fireboxes and three have the long, narrow firebox. Both styles of firebox have been fired satisfactorily by the Victor mechanical stoker. From advices we receive from the division officers, we can safely say there is a noticeable saving in the amount of coal consumed per car and engine mile when operated with the stoker in comparison with hand firing, but at this time we are not prepared to state the exact per cent. of such saving. The same advices indicate a reduction of boiler work, on flues, staybolts and firebox seams, which, in our opinion, is due to the fact that we are enabled to carry a lighter, cleaner and more uniform fire, as well as uniform boiler pressure.

During the six months in which these stokers have been in service the cost of their maintenance has been very light. The principal cost of maintenance is largely due to improper lubrication. What few failures we have had with the stoker are due to the same cause.

In conclusion, I will say it is my opinion the mechanical stoker for locomotives has come to stay.

First—Because it is practical and efficient.

Second—We believe, by the adoption of the mechanical stoker the railway companies will be enabled to use a cheaper grade of coal than can be used in hand firing, resulting in a great reduction in their fuel bills.

Third—It will relieve the fireman of some of his most arduous labor and give him greater opportunity to observe signals while on duty, and he will arrive at the end of his run in condition to improve his chances by study for promotion to the position of engineer.

HIGH-SPEED STEEL—Opened by Mr. J. A. Carney.

The almost prohibitive cost of high-speed steel makes one consider carefully whether or not it should be purchased for all classes of work, and especially for old machines, which cannot tax the capacity of the cheaper self-hardening steels. When one figures that a tire lathe tool costs from $8 to $10, it looks like a lot of money. On the other hand, if we will take into consideration the slower speed, smaller output, time lost sharpening and dressing tools and the loss of material incident to dressing and sharpening, it will be seen that the cheaper tempering and self-hardening steels are too expensive to be considered. A case in question: A set of bolt cutter dies made of 10-cent tempering steel cost 21 cents for labor and 5 cents for material; total, 26 cents, and cut 100 bolts before dressing. A set of similar cutters made of 75-cent high-speed steel cost 37½ cents for material and 40 cents for labor; total cost, 77½ cents, and cut 1,100 bolts before dressing. Enough tempering steel cutters to do the same work would have cost $2.86. This is what I mean when it is said we cannot afford to use low capacity steel.

The use of tool holders and smaller sizes of steel will effect great economies in the investment of high-speed steel, and in one instance the introduction of tool holders reduced the number of pounds of steel required for a wheel lathe over 80 per cent., and instead of a tool 1 x 2 ins., 18 ins. long, costing $7.87, a 1 x 1 x 6-in. tool, costing $1.87, is used, and the tool holder does not wear out or break, and costs 5 cents per pound, against 75 cents per pound for high-speed steel.

Rosebit reamers can be tipped with high-speed steel and increase their efficiency from 750 to 1,000 per cent.; in fact, a little ingenuity and thought will open up economies in the quantity of high-speed steel that were never given a thought when 10-cent steel was used.

Larger section tools of high-speed steel which have become too short can be hammered out into tools of smaller section with excellent results.

High-speed steel has come to stay until some more efficient material is discovered, and while its price may make us question its economy, a second thought will convince us that we cannot afford to go back to the cheaper tool steels for heavy work, however good these may be in their class.

THE TECHNICAL EDUCATION OF RAILROAD EMPLOYEES.

ABSTRACT OF AN INDIVIDUAL PAPER BY G. M. BASFORD.

No other part of industrial development has shown such progress as that of transportation, and no other influence in human welfare is as vital as that exerted by the railroads. In connection with this progress and development, because of its radical character and great extent, the development of men has been allowed to take care of itself until it must be said that the most vital railroad problem of to-day is that of men.

The problem is that of men, the selection, preparation and training of men. If this is provided for the rest is easy. It is said to be less difficult to secure a new president than to secure a good shop or roundhouse foreman. This is, of course, not true, but it certainly is sufficiently difficult to obtain the necessary supply of foremen of the right sort and even more difficult to secure the right kind of men in the ranks. The men are not essentially different from those of a generation ago, but the conditions certainly are different. To improve conditions it is necessary to know what is wrong, and to know what is wrong it is necessary to understand the changes which the last few years have brought.

WHAT GROWTH HAS DONE.

A few years ago railroad mileage was in hundreds, whereas now it is in tens of thousands. The general manager once knew all of his subordinate officials, because they were few and changes were not frequent. He once knew all of his master mechanics, station agents, conductors, engineers, dispatchers and even telegraph operators. They knew him and were working for him because he was personally close to them in their work. All this has changed as the roads themselves became greater and as roads great in themselves combined into systems, as has never been done anywhere else in the world. With this change the officials have by a powerful current been carried far from the men in the ranks and far even from their subordinate officials. From personal friends, the men have become to them as mere numbers.

For example, we have one motive power official who is responsible for the service of more than forty thousand men. How many of them can he know? He does well to really know his chiefs of staff. From a simple business proposition, administration of railroads has become like the direction of the armies of a nation. But armies do not suffer weakness of organization because of increasing in size. An army becomes larger by aggregation of units, which of themselves become no larger. As size increases general officers are added. The commanding officer does not know all his men, but the captains do know theirs. From this standpoint the railroads need more captains, because the subordinate officials now know their men as little as the chiefs know their subordinate officers.

The recruiting and training is the same for a large as for a small army, because the units are of the same size. It is not so with railroads. For example, consider the organization of a new and large locomotive shop compared with a small one. This is one reason why the large shops of to-day are less efficient and less economical than the small ones. Shops have outgrown both men and methods.

THE RECRUITING OF THE PAST.

Considering shop forces, the recruiting of the past was through apprenticeship. It is not so to-day. One of the best equipped railroad boiler shops in the country has not a single apprentice and few of them have enough to be worth mentioning. Of twelve trades in one shop plant only three were found to have apprentices, but all had shop committees. In other departments apprenticeship

has been overlooked and neglected because there was so much else to do. There has been too much pressure to turn out work with existing facilities to admit of taking the necessary precautions concerning the men and the leaders of the future. The present demand for foremen with leadership talent and executive possibilities proves both the neglect of the apprentice and the distance which has grown between the officials and the men, for there certainly must be latent talent, dormant and undiscovered, sufficient for all necessities.

We need to be reminded that many men in the ranks are sure to rise in one way or another. If they are not encouraged in every possible way to qualify for higher positions on the staff they will employ their leadership in other directions, and here is an opportunity to reach one of the roots of the labor problem which has already been allowed to wait too long.

To-day telegraph operators, firemen, trainmen and others are usually taken from outside the service. They receive less preparation for their work than when there was less responsibility and less to do. The recruiting system is at fault, this being considered as unimportant. It is not so in England and in Europe, where the efficiency of the individual railroad employe is of the highest type.

Apprenticeship of the old kind was an ideal method of recruiting. Boys were carefully selected, conscientiously trained, and the employer exercised a moral as well as an educational influence over them. The present pace does not permit of such a system, yet the lack of it has brought a deplorable condition, and to take its place something is needed and that quickly.

A SERIOUS MISTAKE.

For twenty years the railroads have sought to provide the necessary leadership from the technical colleges and many strong officials have developed through what is known as the special apprentice system. It is perhaps possible to meet the immediate need in some such way; but when the technical school graduates come to the railroads, as outsiders, from the schools—as they usually do—this system is doing a fundamental injury, which is neither understood nor appreciated, but it is nevertheless serious. Every time a special apprentice is started on his course notice is, in effect, served upon the men and boys with whom he works, that he, because of his education, is to acquire in a few years sufficient knowledge, experience and ability to become one of the official staff. The effect in the shop is to discourage those who have not had such education. The special training of young men from without the ranks of the workers for official positions is fundamentally wrong, and, furthermore, it plays strongly into the hands of those who wish to see men leveled into classes, and considered as on uniform levels, as to the value of service. It may be necessary to continue special apprenticeship for a time. Technically educated men are needed and will be needed even more in the future, but they should come from the ranks and not from outside of the service. The present system, or any other system, which in any way serves to discourage the regular apprentices and thereby tends to cut off the source from which most of the successful men have come should give place to a system which will encourage all by making it possible for the lowest to become the highest in the briefest possible time, because the talent is needed now. Nothing adequately meeting the needs of American railroads has been accomplished either here or abroad. That such a system is possible and feasible can now be shown.

THE PLAN.

The suggestion is that recruits in shops (and this applies in principle, though not in detail, to other service) should be taken in as apprentices. They should be given shop training, which will increase their earning capacity to the utmost, and they should be placed under the direction of men of such character and moral influence as to lead them to form correct, broad and honest views of life and their proper relations with other men and their employers. Parallel with the shop training, attendance during working hours at a school provided and maintained by the road should be required; and for this a new kind of a school must be developed, as a new kind of apprenticeship must be developed—the kind that will meet the individual cases. They must not be dealt with in classes or by fixed rules. The school must be one wherein the shop and the studies go hand in hand. While the shop hours are taken for the school, home work should be rigidly required. Life must not be made too easy for the apprentices.

For example: Arithmetic is needed of the kind which will deal with pulleys, back gears, lead screws and other studies such as drafting and shop arithmetic, which will reveal the reasons for things seen and done in the shops. The school and the shop should be co-ordinate in every possible way. The local officials must be interested in and responsible for the boys in the school as well as in the shop. The higher department officials must be occasionally seen in the schoolroom and the foremen should be identified with it. An evening a month should be devoted to a general meeting of an apprentice organization, with an occasional stereopticon talk or lecture by a foreman or higher official. Here is an opportunity for the university extension idea. The boys should visit other shops in committees and report their observations for discussion. A library for books and periodicals is a necessary element. If the road has several shops a car should be equipped with valve motion models, sectioned locomotive apparatus and appliances, electric motors and generators and even a small stationary engine for the boys to study, dismantle, assemble and set the valves. The air brake cars have shown us how to use school cars.

As a part of the plan every roundhouse should have a comfortable reading-room provided by the company, with books, periodicals, charts and models. Every encouragement should be given the engineers and firemen to organize improvement clubs. The company should furnish stereopticons and occasional lecturers. Progressive education should accompany the present tendency toward progressive examinations. Here is another opportunity for university extension. Engineers and firemen should be educated to do their best, and it is important to bear in mind the fact that the difference between the work of the best and of the average man represents more to the road than the economies to be obtained from the best fuel-saving appliance or invention ever brought out.

An important opportunity for exerting a strong moral influence is available in this plan and an insight into the history of nations, political economy, the history of labor and the proper relations between employer and employe can be given. The scheme is not Utopian but practical, and the way is plain. The idea has been put by Milton P. Higgins in these words: "The object is to produce many well-trained and educated workmen, some foremen, and from the foremen a few superintendents." This structure represents a pyramid resting upon its base. As long as we seek the genius we stand the pyramid upon its apex and put it into a state of nervous equilibrium. "We may hope for much from a thousand educated, thinking expert American machinists, who have the skill, education and exact knowledge of the shops. Is not the production of one hundred well-educated workmen a more certain undertaking than the production of one genius?"

We are to-day looking for the genius and overlooking the good workmen, but by providing for many workmen we can not fail to find the necessary genius.

This school shop enterprise should be carried out for the individual, lifting each as high as he can go. It should leave the capable student prepared for a course in a technical school. An important part of the plan is a provision for sending, every year, a certain number of graduated apprentices to a technical school, for a short "sandwich" course, at the expense of the company. This should be held out as a prize or reward for high standing in the shop and school. This would provide technical men and they would be admirably prepared. Even if only one out of ten remains in the service the encouragement due to the possibility of securing such an education would affect every ambitious apprentice and every ambitious workman on the road.

With such a system the shop could probably in time supply all firemen, engineers and men for other service, in which the education, training and the *esprit de corps*, which would naturally be developed, would be most valuable. There is no reason why the traveling engineers should not co-operate with the teachers of the apprentice schools in the development of correspondence courses for engineers and firemen and the men would unquestionably respond, certainly as well as they do at present to the commercial correspondence schools. Having the shop schools, they may be taken to the student in every department by the correspondence method, whether he is on an engine, at a telegraph key, on the track or in an office. The development may be as broad as the need, and correspondence courses may be made a vital factor in the plan, and university extension an important element. Those who can not attend the schools must be provided for.

It seems possible that the future of the motive power officer and of his department, and of other officers as well, may become clearer and the outlook may be brighter when the needs are provided for in such a way. The word education, as distinguished from instruction, seems to represent what is needed, and it is clear that the education of managements and owners of railroads is the first step to be undertaken. If this is done there will be no problem too difficult to be solved, but if not there are many impossible of solution. Only in some such way as this can the officials get close to the men directly or indirectly.

No railroad with a constantly changing policy, or one on which the tenure of official life is uncertain, should for a moment seriously consider such a suggestion as is here outlined.

Shall this (or something better) be done? The writer believes that the future, not only of the motive power officer, but of the railroads, and to a large extent of the country, depends on the answer.

There is no need of worrying about the college man; he is fully capable of taking care of himself, and it will be really a favor to him to put him entirely upon his own resources. He should not be handicapped by being labeled, because of his education. Special provision in the shops for the graduate of a technical college should not be made. Employers should not modify their methods for him. To do so is not advantageous to the college man, or to the other men in the shops.

The condition and position of the superintendent of motive power should be elevated and improved, so that young men will see that they can afford to spend their lives preparing for the highest positions. They will then be impressed with the fact that to secure such a position is worth a lifetime of conscientious and unwavering effort. This is not the case to-day.

CONCLUSION.

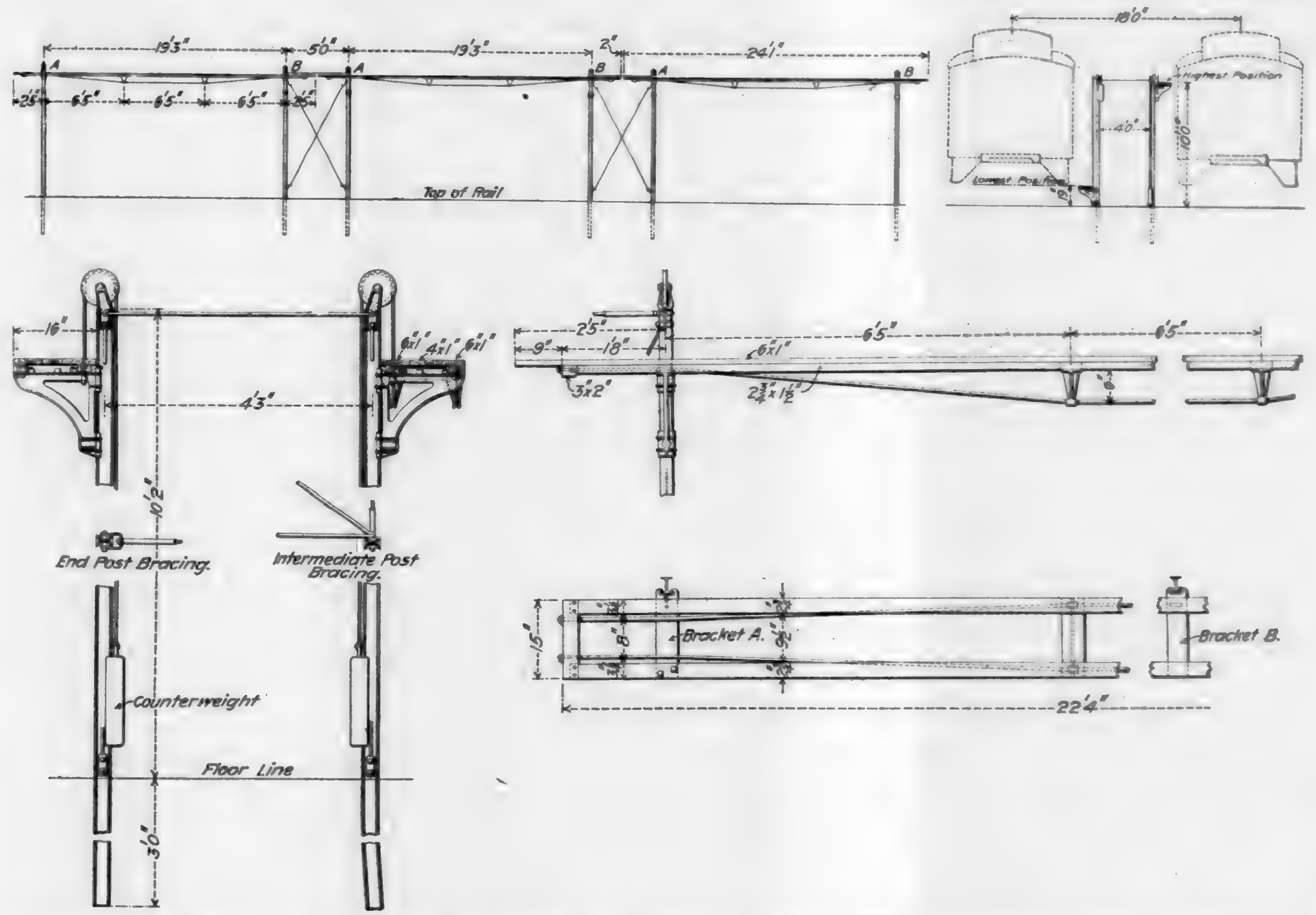
For the men and officials of the future, technical education is required, but it must be obtained while the student otherwise prepares himself for his work. It must go hand in hand with his education in the service, and the education must be arranged especially to suit his needs. For the engineering education he must not be required to fit himself to existing schools. A new school must be developed specially for him. Instead of giving years to subjects which are merely good for mental training, he must give months to those which he will remember. Moreover, he must not separate himself from active work and responsibility for long periods in order to attend school.

An adaptation of the Admiralty and Drummond plans would seem to fit American railroad conditions. These developed naturally, quietly and effectively. They are the work of broad-minded men. When the men who are making American railroads interest themselves in the problem an even greater plan will be forthcoming. They should not delay, for the need is imperative.

Are we a nation so enveloped in a cloak of progress that we cannot see the future?

ADJUSTABLE SCAFFOLDING FOR PASSENGER CAR PAINT SHOPS.

The adjustable scaffolding for passenger car paint shops, illustrated on the accompanying drawings, is in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway and is notable because of its simplicity and the ease with which the platforms can be moved up or down. These afford ready access to any portion of the outsides of the cars, as they may be easily adjusted from their lowest position of 19 ins. above the floor level to the highest position of 10 ft. above. The platforms are carefully counterweighted and thus move up and down with ease.



ARRANGEMENT AND DETAILS OF ADJUSTABLE SCAFFOLDING FOR PASSENGER CAR PAINT SHOP.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The posts which support this system of scaffolding consist of 6-in. I-beams, arranged in double rows, 4 ft. 3 ins. apart, between each row of tracks in the paint shop. The posts are set 3 ft. below the floor in concrete, extending 10 ft. 2 ins. above, and are carefully braced laterally by tie-rods, connecting their tops. Between sections of the platforms, where four posts are grouped together, both lateral and diagonal, and longitudinal bracing are resorted to in order to stiffen the entire structure. The posts between the wall of the building and the track nearest it are similarly braced from the wall.

The platforms are carried upon cast-iron brackets of special construction, having special grooved guides at the rear so as to slide up and down the flanged portion of the I-beam, as shown in the drawing of the scaffold. The platform consists of three planks, 24 ft. long, carefully trussed, as shown, making a substantial walk-way 16 ins. wide. This is flexibly carried upon the iron brackets to allow for inequalities of height of the two ends. The weight coming upon the bracket is supported directly by a cable, passing over the pulley at the top of the I-beam, to the counterweight at the rear, as shown. The height of the platform is readily changed by merely lifting it up or down, the counterweight holding it in the desired direction. The smaller detail view appearing in the drawing of the scaffold indicates the relative locations of the platforms between the cars upon the tracks and also the clearances.

WHAT A FEW MODERN MACHINES WILL DO.

The following figures are from a road, the name of which must be withheld for the present. Several years ago a new era in its motive power department was inaugurated, and the results are indicated in the accompanying table, which includes the number of locomotives added to the equipment in four years, the increase in the aggregate tractive power and the advance in the shop output.

With an increase of 40 per cent. in the number of locomotives, an increase of 75.8 per cent. in the aggregate tractive power, there has been an increase of 80 per cent. in the number of locomotives repaired in the shops over the number repaired in the year 1900. According to the official who supplied this information, "the only increase in facilities that we have had to accomplish these results has been the installation of a few modern machine tools, and using some of the stalls in each of our roundhouses at the main terminals for erecting shop purposes."

ENGINES REPAIRED AND ENGINES IN SERVICE.

	1900	1901	1902	1903	1904	% Inc. over 1900.
ENGINES IN SERVICE.						
Number of Engines.	375	403	428	453	525	40.0%
Tractive Power.	8,588,971	9,708,026	9,794,728	9,932,856	15,100,425	75.8%
ENGINES REPAIRED.						
Total	263	267	295	439	473	80.0%
Av. Per Month	22	22	25	39	40	81.7%

REPORT OF COMMITTEE ON FREIGHT EQUIPMENT.

ROCK ISLAND COMPANY.

III.

(*For previous article see page 206.*)

DESIGNS FOR NEW EQUIPMENT.

The freight equipment of the future should be designed with a view to withstanding the shocks incident to the use of much heavier locomotives and longer trains of higher capacity units than in the past. The committee believes that the practical and economical limit of strength of the wooden car has already been reached with the motive power now in use on the systems, and therefore recommends that steel be used to the largest practical extent in the construction of new equipment.

It is recommended that commercial sizes of rolled plates and shapes only be employed, such as can be purchased in competition in the open market. The use of pressed steel shapes is not considered desirable, owing to the fact that the material cannot be distributed to the best advantage, and that for repairs either expensive machines and dies must be provided, or the parts must be obtained from the manufacturers at the risk of considerable loss of time. The designs have been worked out with a view to using only commercial shapes, in such a manner that they may require only punching and shearing, without the necessity for heating and working in forms or dies. Cars of this construction may be readily repaired at any of the shops of the systems, without any special equipment, aside possibly from pneumatic riveting hammers and cranes for handling floor frames.

The use of steel underframes only, with wooden superstructures is not advocated, from the fact that the steel does not change in size from shrinkage while the woodwork does, therefore the rods and bolts become loose and the whole superstructure becomes shaky and deformed.

The designs contemplate the use of a steel underframe with a steel skeleton superstructure, rigidly secured to the underframe, and braced in such a manner as to retain its normal shape under all ordinary conditions. All closed cars should have floor, lining, sheathing and roofing of wood secured to nailing strips bolted to the steel frame. Coal and hopper cars should have floor, sides and ends of wood secured to the steel frame, it being considered more economical to maintain cars built in this way than those constructed wholly of steel. The dimensions of the cars recommended are as follows:

RECOMMENDATIONS AS TO STANDARD CARS.

BOX CARS.

Length over end sills....................................37 ft. 8 ins.
Width over side sills....................................8 ft. 7¾ ins.
Clear inside space....................36 ft. 7 ins. x 8 ft. 6 ins. x 8 ft.

FRUIT CARS.

Length over end sills....................................37 ft. 8 ins.
Width over side sills....................................8 ft. 7¾ ins.
Clear inside space....................36 ft. 7 ins. x 8 ft. 6 ins. x 8 ft.

STOCK CARS.

Length over end sills....................................37 ft. 8 ins.
Width over side sills....................................9 ft.
Clear inside space....................36 ft. 7 ins. x 8 ft. x 7 ft.

FURNITURE CARS.

Length over end sills....................................41 ft. 1 in.
Width over side sills....................................9 ft. 1¾ ins.
Clear inside space....................40 ft. x 9 ft. x 10 ft.
Length over end sills....................................51 ft. 1 in.
Width over side sills....................................9 ft.
Clear inside space....................50 ft. x 8 ft. 10¼ ins. x 9 ft. 9 ins.

REFRIGERATOR CARS.

Length over end sills....................................41 ft. 1 in.
Width over side sills....................................9 ft. 1¾ ins.
Clear inside space between tanks..33 ft. 6 ins. x 8 ft. 3 ins. x 7 ft. 6 ins.

GONDOLA CARS.

Length over end sills....................................41 ft. 1 in.
Width over side sills....................................9 ft.
Height over side planks....................................4 ft.
Clear inside space....................40 ft. x 8 ft. 8½ ins. x 4 ft.

FLAT CARS.

Length over end sills....................................41 ft. 1 in.
Width over side sills....................................9 ft.

HOPPER CARS.

Length over end sills....................................34 ft.
Width over side sills....................................9 ft. 6 ins.
Height from top of rails to top of sides....................10 ft.

Owing to traffic requirements, it is not possible to use a single standard for floor framing for all classes of cars, and the committee does not understand that the benefits, from a maintenance standpoint, would offset the expense of hauling the extra dead weight that would be imposed upon some classes by the use of a single standard.

The lengths and widths recommended are based upon traffic requirements as nearly as possible, and call for longitudinal members of but two lengths and transverse members of but three lengths for all classes except the hopper cars, which, necessarily, are in a class by themselves.

The center sills and draft rigging should be of uniform strength for all classes, as the strains imposed in service are not related to the carrying capacity, trains being made up of cars of all descriptions and a low capacity car may be placed between a number of high capacity cars.

The capacity recommended is 60,000 lbs. for all classes except gondola and flat cars, which are to be 80,000 lbs., and hopper or other types of self-clearing cars, which are to be 100,000 lbs. There will, therefore, be but three capacities of trucks required, all being of the same general types and of as few parts as possible.

The committee desires to state that cars of the same general construction as those shown by these designs have given very satisfactory results in service on a number of roads, hence they feel that the foregoing recommendations are in the line of actual practice rather than of theory.

The committee also desires to call attention to the recently introduced type of self-clearing gondola cars, which have flat floors from end to end, the floors being composed wholly of doors, which when dropped discharges the entire load without shoveling. As the floors are flat, the cars are available for all classes of traffic for which an ordinary gondola car can be used, as well as for construction purposes, and it is thought that this type might be a valuable addition to the equipment. Such cars may be built with steel framing in the same manner as the design recommended.

HECTOGRAPH FORMULA.

A reader recently asked for a formula for making hectograph pads, and through the courtesy of Mr. H. E. Smith, chemist and engineer of tests of the L. S. & M. S. Ry., we were enabled to furnish the following information:

Clear hide glue, 1 lb.
Water, 1½ pts.
Glycerine, 2½ pts.

The glue should be of a good quality, and the kind that comes in transparent, light-brown sheets, as the white or brown opaque glue does not give as good results. Break the glue into small pieces and soak it in the water over night in a covered vessel. Then melt it in a water bath, and add the glycerine, which should previously be heated to the same temperature as the melted glue. Stir only as much as is necessary to mix the glue and the glycerine, as too much stirring introduces air bubbles, which are difficult to remove. Pour the hot mixture through a cheese cloth bag into the pans. When the pans are filled and the jelly is still quite fluid, sweep off air bubbles or impurities from the surface with the edge of a card. Let the pans stand 48 hours before using. This formula calls for much less water than usually required by other formulas, since it is preferred to secure the requisite softness by means of the glycerine, which does not evaporate and allow the pads to dry out and harden, as does the water.

In writing the original copy always use hard, glazed paper and write with hectograph ink. In making the negative moisten the surface of the pad with a cold wet sponge, wiping off the excess of moisture. Dry off with a newspaper, and let it stand for two minutes. Place the original face down on the pad for from one to three minutes, rubbing down to a perfect contact, and then carefully remove. In printing apply a clean sheet of any kind of paper so that it touches the hectograph at all points, rubbing as little as possible. Never use hot water for removing the negative; as soon as the copies are all made, wash off with a sponge and cold water and dry off well with a newspaper. Never let the pad stand with ink in it after the copies are made, and always keep it closed when not in use.

IMPRESSIONS OF FOREIGN RAILWAY PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

One reason for the relative lightness and comparatively small heating surface of German locomotives is the limitation of weight allowed per axle. In continental practice designers are limited to loads of from 14 to 16 tons per axle and because of these limits it has been necessary to avoid all unnecessary weight. While this limits the power of the locomotives it has not been altogether detrimental because the Germans have been obliged to utilize the weight to the best possible advantage. This has resulted in a refinement of design in the matter of detail parts which is admirable and has already been mentioned in these letters. I should say that it will be impossible to remove an ounce of metal from the main rod of a German passenger engine or from any part of the valve gear, yet these parts never seem to break or give anything like the trouble we have with much larger parts. The advent of the superheater in German locomotive practice doubtless resulted from a desire to increase the boiler capacity without extending the limits imposed upon weight. These restrictions therefore have proved beneficial to the locomotive world in general.

German practice of about 10 years ago employed from 1,400 to 1,500 sq. ft. of heating surface and about 26 sq. ft. of grate area, giving a ratio of from 1 to 55, or 1 to 60. The present tendency is to increase the heating surface to a little more than 1 to 60. The Baden State railways use a little over 2,100 sq. ft. of heating surface in a ratio of 1 to 60. The Prussian State railways were late in advancing in the matter of capacity; the trains are now limited to 40 axles, and will soon be permitted to reach 44. With 40 axles and 10 cars the maximum trains weigh about 350 tons. The statutory speed limits are 62 miles per hour, but because of the Berlin Zossen high-speed experiments, the limit of speed is likely to be increased. Boiler forcing is not popular in Germany, and an output of one h.p. for two sq. ft. of heating surface is considered to be questionable forcing. A speed of 55 miles per hour with 350 tons on level track is considered excellent work in Germany. One of the Atlantic type locomotives of the Baden State railways, which is the heaviest passenger locomotive in Germany, has maintained an evaporation of 13.2 lbs. of water per sq. ft. of heating surface per hour, and kept this up steadily for an hour. This work required 90 lbs. of coal per sq. ft. of grate per hour, with an evaporation of 7½ lbs. of water per pound of coal, and required a smokebox vacuum of 5 ins. This locomotive weighs 74 tons.

The Germans adjust draft in the front end with a blast pipe, raising the pipe to draw the front end of the fire and lowering it to draw the back end. They do not use our diaphragm plates. Professor von Borries finds that 50 per cent. more draft is required if the diaphragm plate is used, and in this he agrees with the results of the AMERICAN ENGINEER tests on locomotive front ends.

Prof. von Borries has had a great deal of experience with two-cylinder as well as four-cylinder compounds, and opinions expressed in his article in this journal in May are exceedingly valuable. He does not consider four-cylinder compounds more economical than two-cylinder compounds, but does find them more economical in repairing. The four-cylinder arrangement prevents the knocking of boxes, and the stresses are equalized by the four cylinders, which reduces weaving and working of the frames and everything else between the driving boxes and the cylinders. He has gone very thoroughly into the subject of balancing the four-cylinder compounds, studying the subject by the aid of an elaborate model. He does not bother to balance the reciprocating parts, and prefers coupling all four cylinders to one axle, because the stresses in the axle tend to neutralize each other, and he finds that this arrangement produces smaller stresses in the axle than in the case of the engine which is divided with the outside cylinder coupled to the rear driving wheels. He also prefers his arrangement because of accessibility and less complication. His remarks on valve gear, cut-off and cylinder ratios in his article for this journal are specially worthy of note.

We would consider the boilers of German engines very small; however, a 74-ton engine which will haul a 300-ton train 68 miles in an hour is certainly doing excellent work. Prof. von Borries insists upon brick arches, and he aims to secure air admission, through the grate, amounting to one-third of the grate area; he does not, however, attain this figure. Walschaert valve gear and modifications of it are the rule in Germany. It is used so generally because of a theoretical constant lead, the long valve travel, uniform distribution of steam and the directness of the connections. While the inside motion is preferred because it is protected from dirt, and is out of danger of being hit, the gear is not by any means confined to the inside construction. Men in charge of maintenance, however, greatly prefer the outside arrangement because of its accessibility.

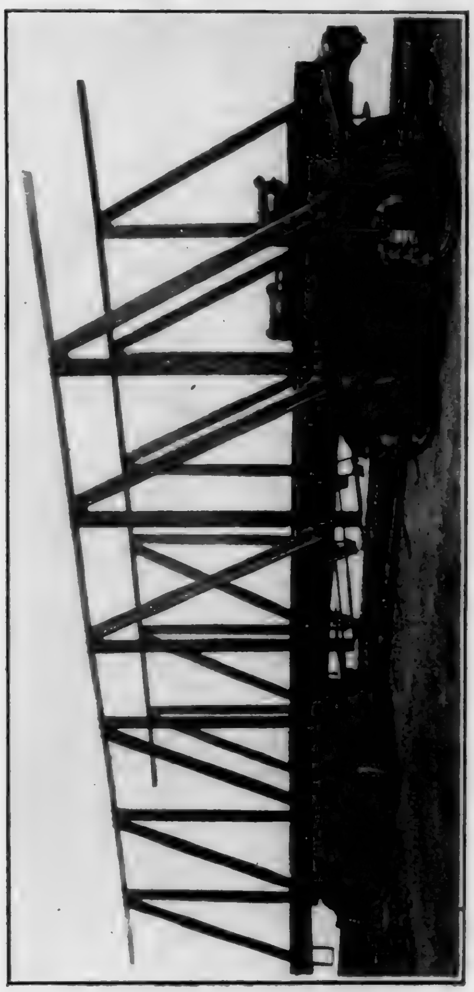
Superheating in Germany requires specially careful treatment in order to represent it properly. It is always necessary to use extreme care in estimating the value of such a principle, because of the tendency to place its claims in the most favorable light possible. For this reason I did not form my opinion until after I had talked with a number of cool-headed railroad men, who could not be accused of being too enthusiastic on this subject. Superheating in Germany has established itself because the principle is accepted as good. It has made an excellent record in freight as well as passenger service. The steam is remarkably quick in its action, and care is required to prevent pounding of the boxes in fast engines. Because of the rapidity of the movement of the steam through the pipes and passages 6-in. piston valves are the rule, and our 15-in. piston valves at home look absurdly large in comparison. The liveliness of superheated steam is, I believe, one of the important advantages of this principle, which has not yet attracted sufficient attention. Especially because the boiler of the superheater locomotive is always ready for a wide range of work and speed, superheating has made a very fine record in freight service. For very fast service, however, the compound has made a better showing against the superheater than in slower service. I find everywhere a rather strong tendency towards the belief that a combination of compounding and superheating gives the best possible records, but for my part I cannot see the necessity for compounding if the superheating is sufficient to maintain dry steam at all times.

As to valves, I was told of an experiment showing a leakage of 3,300 lbs. of steam per hour through a plug piston valve while a plain piston valve with rings did not leak more than 440 lbs. of steam in the same time. In the first case 20 per cent. of the power of the engine was lost through the leakage. It is possible that this plug valve was not properly fitted, but if piston valves with rings work so satisfactorily in connection with superheating in the United States, we need not hamper superheating with leaky plug valves without rings. Superheating has certainly had the advantage of influential advocates in German practice, otherwise in such a short time it would have been impossible to introduce over 100 superheater locomotives into this service in such a conservative country. While economy is an item of great importance in Germany, because of the cost of coal, the argument of increased boiler capacity provided through the superheaters is a more important one. The Germans do not like large boilers, or high boiler pressure, and high superheating is advocated on these grounds and also because of a desire to reduce the amount of double-heading, which has become necessary in freight surface. Superheating in Germany is not in any sense a fad. It was taken up for good and sufficient reasons, and I am sure it has come to stay. Before these paragraphs are printed I am sure that we shall have nearly as many superheater locomotives running in the United States as are now running in Germany.

G. M. B.

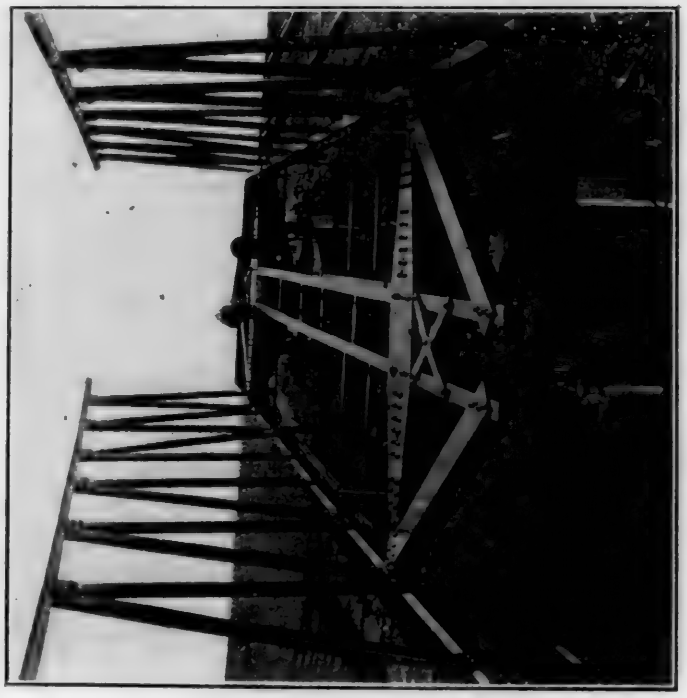
(To be concluded.)

GENERAL SIDE AND END VIEWS.



SHOWING CONSTRUCTION OF SIDE FRAMING.

50-TON COMPOSITE COAL CAR.—FRISCO SYSTEM.



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Drawings and photographs have been received from Mr. W. A. Nettleton, general superintendent of motive power of the Frisco System, illustrating the 50-ton hopper coal cars built for that road by the American Car & Foundry Company. The general design of this car is similar to the Norfolk & Western car of the same type, illustrated in this journal in February, 1901, page 43, and referred to in the article in the June issue describing the latest Seaboard Air Line car. The trucks of the Frisco car are of the standard arch bar type on that road for cars of 50 tons capacity. These trucks have Simplex bolsters, Symington oil boxes, inside hung brakes, Simplex brake gear and Miner draft gear. The photographs show the end framing and side framing.

The general dimensions of the Frisco car are:

Length inside	30 ft. 9 ins.
Length over end sills	33 ft. ½ in.
Width inside	8 ft. 9½ ins.
Width over sides	9 ft. 2 ins.
Height inside	7 ft. 11 ins.
Height over brake staff	10 ft. 6⅛ ins.
Capacity in cubic feet	1,583
Capacity in lbs.	10,000
Weight	39,000 lbs.

EFFECT OF OIL IN BOILERS.—The temperature of steam at 200 lbs. is 380 deg.; the temperature at which steel commences to lose its tensile strength is 650 deg., and at 1,200 deg. about 10 per cent. of its original strength has disappeared. If the surface of a furnace in a boiler for, say 200 lbs. pressure, were clean, the temperature of the metal would never reach the point at which its original tensile strength would be appreciably reduced, even under very high rates of evaporation. If, however, the surface were simply rubbed over with a very thin coating of mineral oil, the temperature would at once rise to over 650 deg., even with a moderate rate of evaporation.—*D. B. Morison, before Northeast Coast Institution of Engineers and Shipbuilders.*

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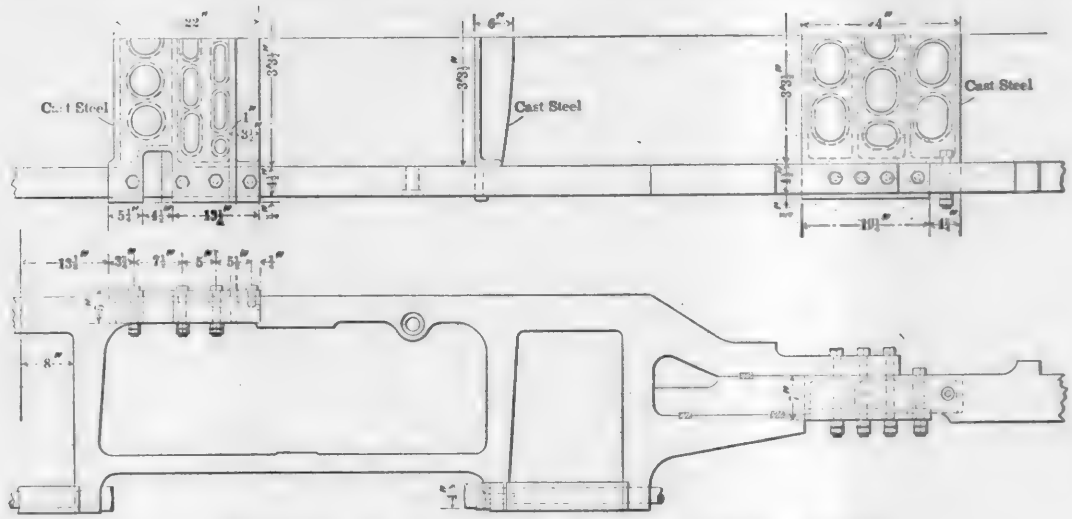

APPLICATION OF FRAME BRACES.—MICHIGAN CENTRAL RAILROAD.

LOCOMOTIVE FRAME BRACING.

With the increasing capacity of locomotives a general difficulty has arisen in the breaking of frames. Mr. E. D. Bronner, superintendent of motive power of the Michigan Central Railroad, has made a careful study of this subject and has supplied information concerning remedies which have been applied with notable success. A number of frames of 21 x 26 in. 4-4-2 type locomotives had broken at the front splice. After studying the breakages and investigating the "working" of the frames by riding on the running boards, rendering it possible to closely observe the frames when the engines were working, the conclusion was reached that the stresses leading to breakage might be distributed by tying the frames together across the engine. Of six locomotives of this type five broke their frames before the bracing was applied; the sixth locomotive was fitted with braces after it had been in service about six months and the frames have not broken since. It seems reasonable to suppose that the bracing accounts for this result. The accompanying engraving illustrates the braces and their application. It appears that the bracing transfers considerable stresses, because a number of the brace bolts have been found broken in service.

In connection with this study of frames it has been noted that forged frames after being broken and repaired have given no further trouble. This seems to be due to the fact that when repaired by welding the parts are never restored to exactly the original length, and this apparently indicates the existence of excessive internal stresses in the frame structure caused by forging it into shape. In many instances side bolted patches have been applied very successfully. The amount of flexure of the frames noticed in this investigation has surprised those who watched it as the locomotives were working hard, although no attempts were made to measure it, as was done in the interesting tests on the Lake Shore, which were illustrated and described on page 8 of our January, 1904, issue.

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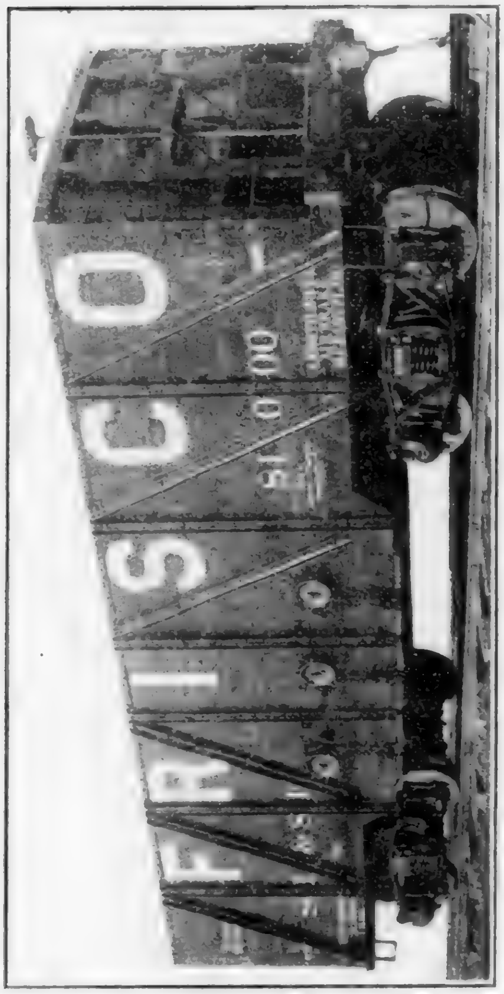
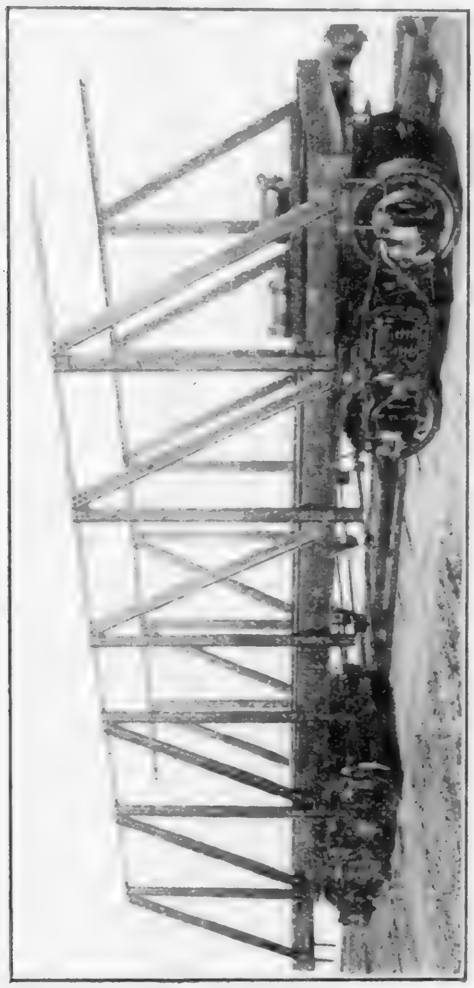


CENTRAL SILL AND UNDERFRAMING.



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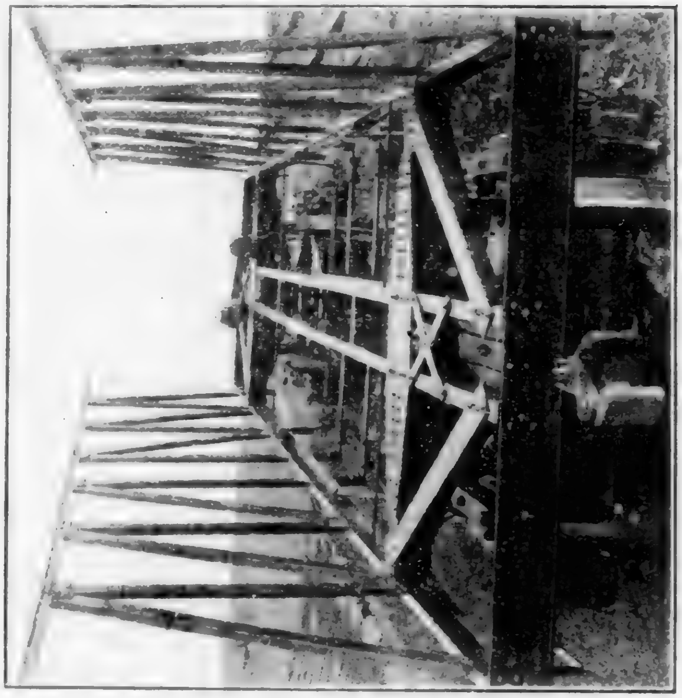

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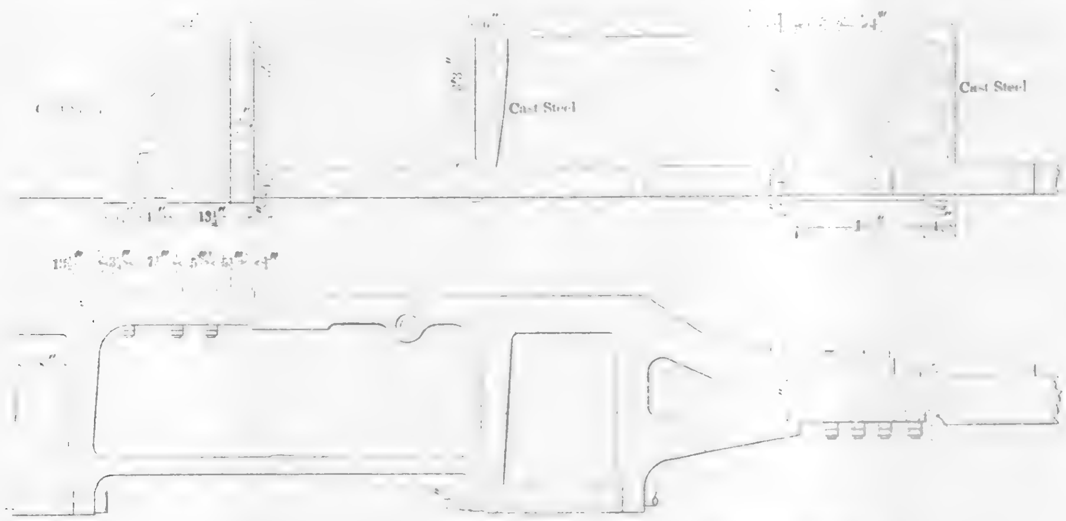

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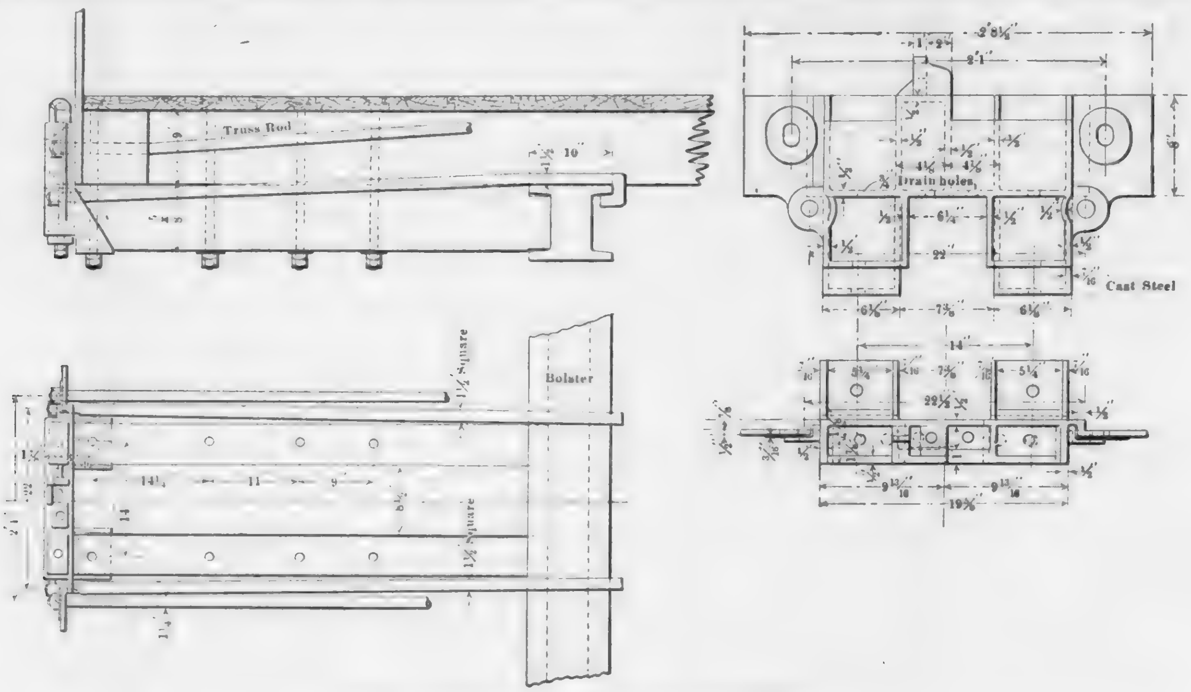

DRAFT TIMBER END CASTING AND DEAD-WOODS.

DRAFT TIMBER END CASTING AND DEAD WOODS.

St. Louis Southwestern Railway.

A combination of draft timber end casting and "dead-woods" in a single steel casting has been developed and applied by Mr. T. E. Adams, general master mechanic of this road, for application to wooden cars. Its purpose is to reduce the number of parts, and support the draft timbers in such a way as to reduce the breakage of draft timber bolts. This construction dispenses with chafing irons, chafing iron bolts, dead-woods and dead-wood plates. It protects the draft timbers from damage in case the followers break and the coupler is driven back. It distributes the stresses on all the sills through the bolster, and relieves the draft timbers of tensile stresses. It is impossible to break the draft timber bolts unless this steel casting breaks or the squared rods leading to the bolster give way. In new cars the ordinary dead-woods may be dispensed with, and this construction may be used on any class of cars, being specially desirable in connection with metal bolsters. In the drawing the large casting has a lug, providing a bearing for the coupler unlocking rod. These drawings were received from Mr. Adams, by whom the device has been patented.

SAND HOUSES.—BALTIMORE & OHIO RAILROAD.

The Baltimore & Ohio Railroad has as its standard design a sand house apparatus that has proven most successful and the best arrangement for handling and drying sand for locomotive use. This arrangement of sand house has been applied to quite a number of the recently constructed roundhouse terminals and coaling stations at Brunswick, Md., Cumberland, Md., Keyser, W. Va., Fairmont, W. Va., Holloway, Ohio, and Glenwood, Pa., New Castle Junction, Pa., etc.

By it the wet sand storage is placed at the head end of the coaling trestle and the cars containing the wet sand are placed over the storage bin and the sand discharged from self-dumping cars. The wet sand storage bins have a capacity of 70 car loads, or 2,100 tons.

The sand drying room is located in the center of the wet sand storage bin and as the wet sand is stored on a level with or above the eaves of the roof of the drying room, it is conducted into the hopper of the sand stoves by gravity. When the amount of sand in storage comes below the roof of the drying room the sand is then shoveled into the stove hoppers. When any part of the sand in the stove hoppers becomes burnt and thoroughly dry it flows through the meshes of the netting and falls to the floor onto the dry sand hopper, from which it is conveyed to the sand tank by gravity. After the dry sand tank is filled the application of about 50 lbs. of air pressure closes the sand inlet valve and automatically forces the dry sand upward into the dry sand storage bin, from which it is conveyed by a suitable arrangement of valves and spouts into the sand boxes on the locomotives.

A Flood of Engineers.—A proportion of 15,000 students in American engineering colleges to a total of 40,000 engineers employed in the United States and an influx of 4,000 graduates annually with only 2,000 required annually to keep up the supply, forms the basis of an admirable discussion of technical education in *Engineering News*. This article shows that the number graduated from law and medical schools is not more than is required to keep pace with the natural annual growth and the conclusion is drawn that at the present rate competition between engineers will increase as a matter of self-preservation. *Engineering News* urges for engineering students more attention to commercial, cost keeping and administrative studies, so that engineers may be in position to operate the machinery produced by engineers, in which the railways are included. Among other important suggestions, this article presents the following: "In spots here and there we see evidences that the engineer has taken hold of the machinery that he has planned and is operating it. The future holds its greatest rewards in store for those engineers who are the first to seize upon the directing of the forces that are now in the hands of untrained men." In the past the man who has come up from the ranks has built the railway and another man equally self-made has operated it. The opportunity for the engineer is to apply his talents in its operation.

Steel Cars for Street Service.—Following the lead of the Interborough Rapid Transit in the equipment for the New York Subway, the New York City Railway is making a trial of a street car constructed of steel. An experimental car built by the Pressed Steel Car Company made a trial trip June 5th with Mr. H. H. Vreeland and officials of the railway, accompanied by Mr. F. N. Hoffstot, president of the Pressed Steel Car Company. An interesting development of street cars built of steel may be expected to result from this experiment.

COMMUNICATIONS.

BELPAIRE BOILERS.

To the Editor:

One who has watched the development of European locomotives cannot fail to be impressed with the rapidly increasing use of the Belpaire fire-box. It is used on nearly all recent French locomotives, or perhaps half of the latest English engines, and on much of the modern equipment of the Prussian and Netherlands state railways. The construction of this fire-box provides excellent flexibility to take care of unequal expansion, while the radially-stayed boiler resists such expansion with almost perfect rigidity. The crown stays can be inserted perpendicularly into both sheets, and the form of the outside, or wrapper, sheet is such that it is not altered by internal pressure, while it is well known that the shape of the radially-stayed boiler is altered by the pressure, to the injury of the sheets and, perhaps, the staybolts; and possibly the problem of leaking tubes would be simplified by the adoption of a stable form of fire-box For large engines where clearance limitations prevent the use of much of a wagon-top, the Belpaire boiler offers the maximum steam space and free water surface possible. The writer believes that, whenever fair records of the comparative cost of maintenance have been kept, the rectangular form has justified its greater first cost. The occasionally-heard objection that the cross-stays impede circulation is untenable, for the increase in area of cross-section above the fire-box supplies more than the space necessary for the cross-ties. It is difficult to conceive of a device more poorly suited to its purpose than the radially-stayed boiler; and we may look for a revival of the Belpaire type as a characteristic feature of the next step in the development of the Americal locomotive. G. F. STARBUCK.

Waltham, Mass.

JIG AND TOOL ROOM IMPROVEMENTS.

To the Editor:

During the past nine years I have been employed as a machinist and draftsman, by a number of railroads in different sections of the country. A year ago I decided to leave railroad work to enter the service of a private concern at nearly double the salary I was receiving as a draftsman with one of the foremost railroads of the country. After six months with my present employers I was promoted to take charge of the department of jig and small tool designing, with orders to go ahead and design a line of tools for interchangeable manufacturing. This was so successful that within the last three weeks another raise of salary has been given me. A careful study of this line of work, together with a number of articles which have appeared in your journal, advocating systematizing and improving tool room practice in railway repair shops, has led me to believe that there is an excellent field for this work among the railroads. My experience as a mechanic has shown me that a vast amount of time and labor in railroad shops can be saved by a man who can devise ways and means of standardizing methods of manufacturing and repairing locomotive parts, also standardizing the parts themselves. I would like your opinion on this subject and upon the advisability of my returning to railroad work. I feel drawn to this work because of its interest and would be glad to again enter the service of a railroad to apply the knowledge and experience gained in connection with the jigs and the systematic tool room work in a manufacturing establishment. Railroads ought to appreciate the importance of this work. Do you think it would pay me to go back to my first love?

D. G. R.

EDITOR'S NOTE:—The advice given this young man in reply to this letter was that he should by all means return to railroad service, where commercial experience in connection with jigs and tool room improvements is more greatly needed than in any other line of manufacturing. In enumerating the roads paying a sufficient amount of attention to this class of work to warrant his entering the service without a sacrifice, it was impossible to give a large list for application for a position. The difficulty is that, much as one may dislike to admit it, railroads as a rule have not given a sufficiently high place to the idea of manufacturing in improving their shop methods. In the matter of special devices and jigs there lies a very great opportunity for improvement of shop methods, because though a plant may be well equipped with machinery and improved tool steel the time which may be saved by devices for laying out, setting and holding the work constitutes a large possibility of saving. This is because, as a rule, the time during which the machine is actually cutting bears usually a small proportion to the total time of doing the work. In this particular direction lies the greatest opportunity for the introduction of manufacturing methods, and it may be said that the nearer railroad shop practice approaches to commercial and manufacturing methods, the greater will be the output and the less the cost. The name of the author of this letter will be given to any one who is interested to inquire.

THE FORCE OF A BOILER EXPLOSION.—The boiler which exploded March 20th in the factory of R. B. Grover & Co., Brockton, Mass., with such disastrous results, was of the horizontal tubular type, 72 ins. in diameter and 17 ft. long. It carried 90 lbs. pressure, contained 240 cu. ft. of water and 103 cu. ft. of steam, the total weight of the water in the boiler being about 14,000 lbs. The April number of *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, contains an interesting and complete account of the disaster, which was caused by a hidden crack in a double-riveted lap seam. The discussion referred to includes a statement that the "maximum mechanical energy that could be developed from the heat that this boiler contained would, if it were applied properly and efficiently, be sufficient to raise the boiler and its contents to a height of 18,954 ft., or over three miles and a half." It is not stated that this was the amount of energy that was developed in the explosion, but this calculation shows the possibilities in such a case without any gratuitous assumptions as to the use or presence of dynamite or other high explosives.

POWDERED FUEL.—"Firing With Coal Dust" was the subject of a paper by Mr. E. Carey before the Liverpool Section of the Society of Chemical Industry. In connection with the Schwartzkopff system, the cost of drying and grinding coal, including repairs, depreciation, capital cost and wages, amounted to 10.7c. per ton, and the capital charges and wages for firing the fuel amounted to 8.24c. per ton, including the cost of the power for driving the machinery. The cost of the power amounted to about 2.6c. per ton of fuel, and that for the mechanism for feeding the powdered fuel amounted to about .54c. per ton. The total cost of preparing and burning a ton of powdered fuel was 22.14c. per ton. In the experiments described a 500-h.p. Sterling boiler was used, consuming about 50 tons of powdered fuel per week. The Schwartzkopff system of burning powdered fuel was illustrated on page 378 of this journal in December, 1900.

A SUCCESSFUL WOMAN PRESIDENT.—Mrs. S. A. Kidder, who succeeded her husband, the late John F. Kidder, as president of the Nevada County Narrow Gauge Railroad, in 1901, has brought that road from a wornout and wretched financial condition to a basis of 10 per cent. dividends on its capital stock. The road is 23 miles in length, of 3-ft. gauge, having 5 locomotives and 79 cars. For 18 years it had paid no dividends and is now in excellent financial and physical condition; the credit being unquestionably due to the ability of Mrs. Kidder. The San Francisco *Bulletin* presents a very interesting account of this unique performance.

PITTSBURGH'S TONNAGE.—In the busy years of 1902 the freight tonnage of Pittsburgh was 88,000,000 tons, which is double that of London, four times greater than that of Paris, and more than that of Boston, New York, Philadelphia and Chicago combined. It is estimated that this great volume of business will be exceeded in 1905, and it is probable that the railroads will not be able to handle it for want of equipment.—*Railway Age*.

SINGLE FIRE DOORS.—Decided preferences for one instead of two fire doors of wide firebox engines was expressed in a recent discussion before the International Railway Master Boilermakers' Association at Buffalo, a specially favorable report for single doors being made by Mr. B. T. Sarver, of the Pennsylvania Lines.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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TOOL EQUIPMENT FOR LOCOMOTIVES.

A railroad officer engaged in connection with improvements on an important road finds no difficulty in securing appropriations for improvements, because he began by looking up usually forgotten items which involve great expense because of multiplication. In the matter of locomotive tool equipment, he says:

"I expect to effect a net saving of from $30,000 to $40,000 per year on engine tool equipment. Some of our engines now cost us $1 per day for tools illegitimately and others on a tool kit worth about $50 or about 700 per cent. depreciation."

THE VALUE OF CLEAR REPORTS.

In their reports to their superiors young subordinate officials have an opportunity, the importance of which they do not fully realize. A superintendent of motive power, who is noted for his development of young men, requires his subordinates to make reports of special investigations in such form that they may be handed on to higher officials with mere letters of transmittal, thus giving the credit to each young subordinate for his work. When a report is presented in an incomplete or unsatisfactory form, the superintendent of motive power finds it necessary to rearrange the report, transmitting it over his own signature, and thus depriving the young subordinate of this opportunity. In such cases as this the superintendent shows the young man the result of his deficiency, and usually the next report is creditable and is passed on as desired. This superintendent of motive power has for a number of years been constantly surrounded with a lot of able young men, and the young men have under his direction developed rapidly and broadly. In this practice there is a moral for young men and also for motive power officials. The young men do not appreciate the possible importance of a single good report which gives the desired information in the way it is wanted.

PROPOSED M. I. T.-HARVARD ALLIANCE.

To go into the subject of the controversy over the proposed alliance between the Massachusetts Institute of Technology and Harvard University at length would require more space than can be given this subject in these columns. To those opposing this scheme, however, one thing needs to be said, viz., that the future of technical education so admirably begun by Technology is the important object at the present juncture. Giving all due credit to the schools of the past, present conditions in technical education do not seem to be advancing to correspond with the needs of the times, and anything which will broaden and improve the possibilities for training engineers quickly, efficiently and thoroughly should be sought after and earnestly supported by those who are looking into the future. If the proposed alliance offers an opportunity for meeting the educational needs in a better way, and this it seems to do, it should not be opposed by any one, and least of all by those who are proud of what the Massachusetts Institute of Technology has been. That school has had a standing second to none in the world, but it is at least open to question whether it is now advancing at all. It surely has suffered by the inbreeding of alumni into its faculty, and a change of methods seems necessary or it will fail to fill the important position which it has filled in the past. The possibility of producing a better school with the alliance with Harvard seems to have been overlooked in the many discussions, and this is believed to be far more important than any of the objections which have been raised to the possible alliance. Past traditions may be left to take care of themselves in an effort to prepare for the future. [Since the above was written the alliance has been decided upon favorably.]

FOOL-PROOF MACHINE TOOLS.

One of the leading machine tool builders who has spent considerable time in studying railroad machine shop conditions is responsible for the statement that 70 per cent. of the breakages of machine tools in railroad shops is due to the lack of proper care or attention rather than to any weakness of the parts or poor design. An example was cited of an expensive boring mill which had been in a certain railroad shop less than one month when the feed works were badly injured, due to carelessness of the operator in letting the two heads jam together. A number of these machines had been in shops, other than railroad, for a long time, but no accidents of this kind had occurred.

The machine tool builders have done much during the past few years to design their machines to provide against such accidents, and have tried as nearly as possible to make them "fool proof." In addition we find careful provision made for adjusting those parts which are subject to wear and for lubricating such parts with a minimum amount of attention. The machine tool builders are to be commended for their efforts in this direction, but these things are useless if the user of the machine does not regularly supply oil for lubrication and carefully examine the machine and see that all wear is taken up. In an extensive visit to a number of railroad shops only two roads were found where any attempt was made to have the machine tools frequently and regularly inspected and repaired. What better investment could be made in a railroad shop, if the amount and accuracy of the work turned out and the increased life of the tools are considered, than to provide means for systematically and frequently inspecting all the machine tools. There are times when prompt attention requiring a few hours' work will add years to the life of a tool, to say nothing of the greater accuracy of the work it will turn out, and yet how often do we find tools in such shape that a passerby can tell by listening to the rattling of the loose parts that the machine requires attention? When a $10,000 machine tool is operated by a $2 per day man a better grade of attention than he can give is required in order to prevent a high rate of depreciation.

A TREE-CLIMBING CONTEST.

One of the important trunk lines is a conspicuous example of what a railroad ought to be—a happy family of officers and men. It would naturally be expected that such conditions would result in satisfactory and economical operation. In answer to the writer's question, one of the subordinate officials said that the success of Mr. ——, the head of the organization, was due to the manner of that official in dealing with his men. He said: "If Mr. —— should issue a bulletin, ordering every man on the system to climb a tree at 11:15 a. m. to-morrow, you would see the greatest tree-climbing contest since the time of Noah." That was his way of expressing the loyal desire of every man to do what is wanted of him. The official referred to never has had a strike in any department. Many of his young men "stay up nights" to get results for him. They do not count the cost of pleasing him. They do not often leave for bigger offers elsewhere. This results from the personality, the ability of this official, and his thoughtful consideration of his assistants. Think this over.

AMERICAN VIEW OF COMPOUND LOCOMOTIVES.

A true view of the standing of the compound locomotive in the United States was one thing difficult for the foreign delegates to the International Railway Congress to obtain, and after that meeting of distinguished railroad officials has passed into history one of the European delegates writes, asking: "What, after all, is the opinion in America, of the compound locomotive?" After thoughtful study of what was said in Washington this delegate was in doubt, and addressed the question to this journal. The reply was as follows:

Those who have used compound locomotives in this country may be classified roughly into four groups. (1) Those who appreciated compounding from the first, and have made a continual success in using the principle. (2) Those who expected too much of compounding and were not willing to aid in its development. These found improved fuel economy, but increased cost of repairs and increased number of road failures. They have nothing good to say of compounds. (3) Those who understood compounds, were willing to give them the care which all locomotives require, and who wanted the saving in fuel which the compounds rendered possible. (4) The fourth, and most important, class favor compounds because they provide increased capacity for work, and enable the fireman to shovel more horse-power into the firebox. This class is helping in the development of design, and compounds are wanted because they will do work that cannot be done by simple engines. These men realize that compounds are usually heavy, powerful engines, and that they require correspondingly increased care in maintenance because they are large, and not because they are compounds.

STAR PERFORMANCES IN SHOPS.

In a shop having about 1,200 men a number of production improvements have recently been made, one of which has attracted the attention of shop managers all over the country. The superintendent of this shop is pleased to have this record known and in connection with it has said a wise thing to his foremen and other assistants; he has said to them: "We have a fine record on that machine and it is well enough for people to know about it as well as about some other records we are making. You must not forget, however, that each of these particular jobs usually affects one man only in the shop. We must not forget that there are 1,199 other men employed in this plant, each one of which should make his record and that record making should extend even to the darkest corners of the plant. One individual record, or excellent work done by half a dozen men may give reputation to a shop, but what we are after is the record of the whole 1,200 men on the pay roll, which is reflected in the net earnings of the road. We are here for the reputation for net earnings rather than for a few star performances which will catch the eye of visitors but make relatively small impressions on output. Do not forget the 1,199 men."

VARIABLE SPEED FOR MACHINE TOOLS.

While it is undoubtedly advisable to provide such machine tools as lathes, boring mills and drilling machines with a large number of speeds, especially if they are to be used for general work, yet those familiar with railroad shop conditions must feel that the limit has been passed when from 40 to 80 speeds are advocated in connection with these machines. It is questionable if the average operator could work so closely to the limit of the tool steel as to require as many as forty different speeds on an engine lathe even if working under the direction of a speed foreman. The writer noticed in one large shop several engine lathes (16 to 20 ins.) which were seldom required to turn work larger than 3½ or 4 ins. indiameter and yet each one of them was provided with at least 40 different spindle speeds which would give less than 10 per cent. speed steps over the total range of work which it would be possible to handle on such lathes. It would seem that the same results could be obtained in a shop of this kind with a smaller expenditure by assigning certain classes of work to each machine and adapting the speeds to the particular work handled on each machine. This is especially true in the case of lathes and drilling machines.

THE BREAKAGE OF LOCOMOTIVE FRAMES.

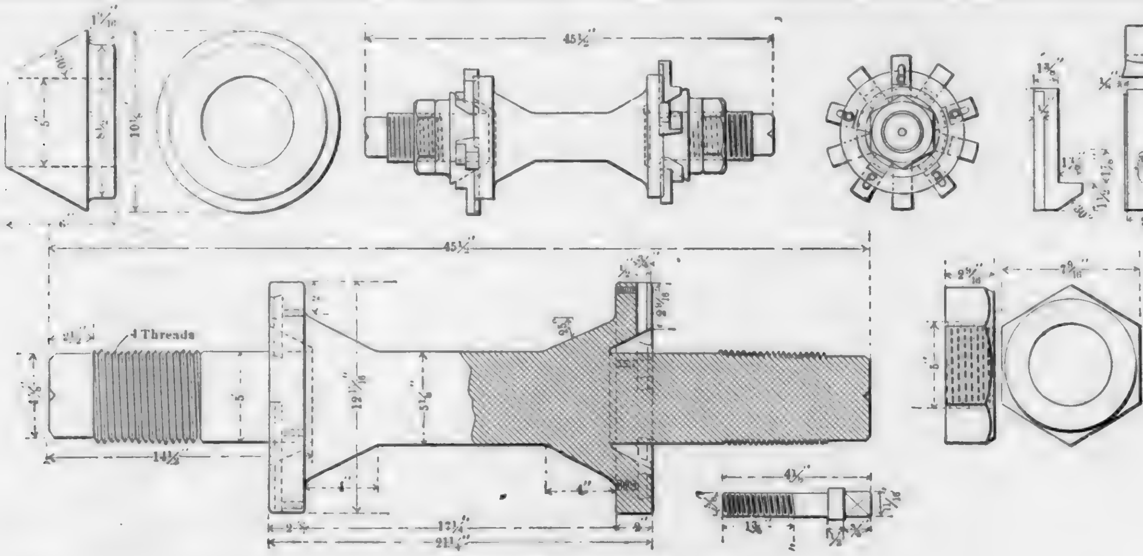
Locomotive frame breakage is becoming a serious matter which troubles everybody who has to do with large locomotives. It does not occur often with the lighter engines of 8 and 10 years ago, but is really mysterious in recent designs. Frames have been strengthened, stiffened and widened without overcoming the trouble or even discovering the reason for it. Some think it due to water in the cylinders and attribute it to the piston valve until they learn that slide valve engines are as bad. Some say it is due to the frequent reversal of the very heavy stresses from the cylinders, coming eccentrically upon the front sections of the frames, between the cylinders and leading drivers where most of the breaks occur.

On the Lake Shore it has been believed to be due to twisting of the frames and thus far engines fitted with deep cross braces, such as were illustrated in this journal in November, 1903, page 416, have not developed this weakness. The new Class K 2—6—2 type passenger locomotives of this road have 6-in. frames which are braced in this way, as illustrated elsewhere in this issue. These will be watched with great interest.

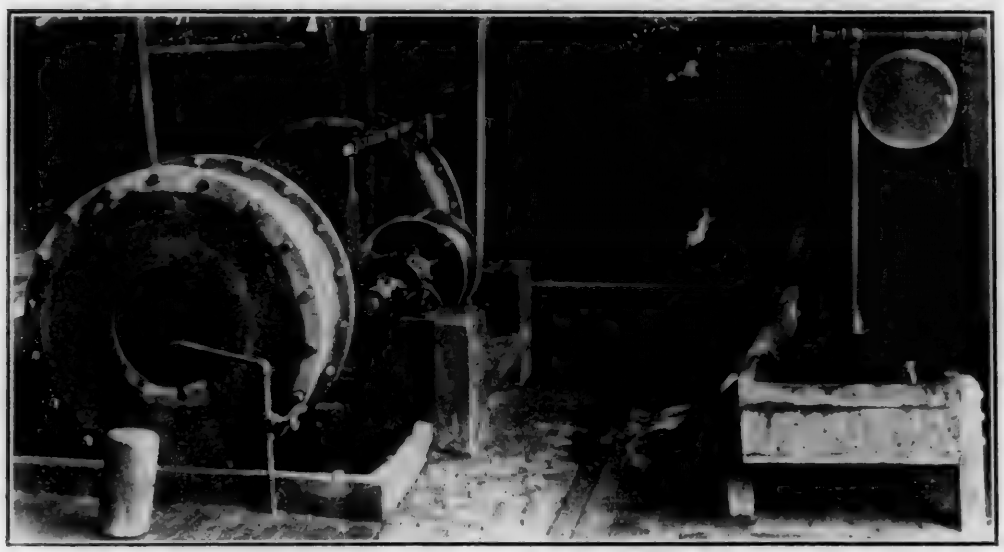
Pedestal binders are now almost always made of rectangular section with ample flat bearing surfaces in the form of notches against which the ends of their jaws bear, and these have prevented most of the breakage of frames over the driving boxes. When bolts are used, water in the cylinders tends to stretch them unless they are made very large, and when large enough they are too large for convenience in the roundhouse.

What seems to be needed is a combination of two remedies. First, to brace the frames laterally as is done by the Lake Shore and, second, to reduce the frame stresses as is done in the four-cylinder balanced compounds. This is one important argument in favor of these compounds where the frame stresses between the forward driving axle and the cylinders are almost entirely neutralized.

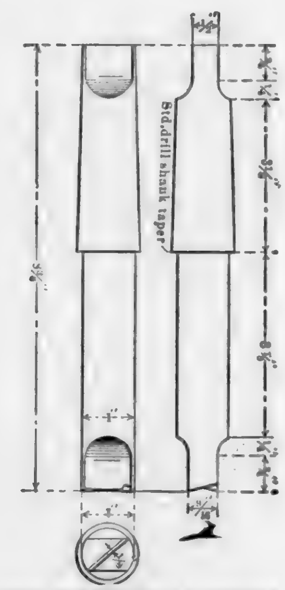
Another possible precaution is to substitute plate for bar frames, and this is an apparently important possibility. Frame breakage has become so serious as to justify a trial of plate frames in two-cylinder engines and it would be wise to investigate the possibilities of such construction in American practice under present conditions. But the plate frames will undoubtedly require the lateral bracing against twisting stresses, as this bracing has for years been practiced in foreign locomotive construction.



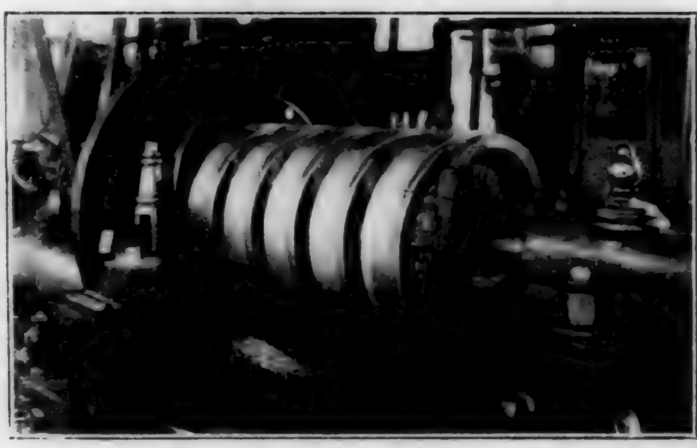
CYLINDER BUSHING MANDREL.



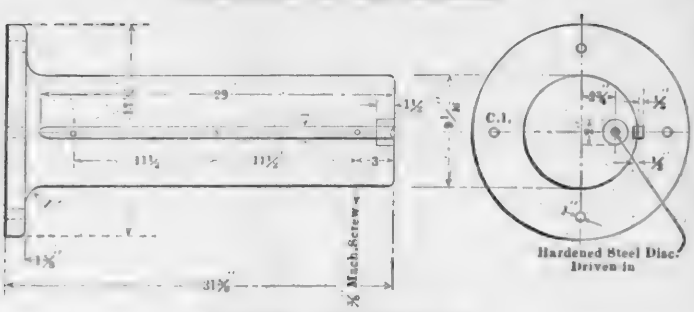
CINDER WASHING MACHINE.



DRILL FOR KEYWAY MACHINE.



ECCENTRICS ON THE MANDREL.



MANDREL FOR ECCENTRICS.

DRIVING AXLE KEYWAY MACHINE.

SUCCESSIVE OPERATIONS IN BABBITTING CROSS-HEADS.

PRODUCTION IMPROVEMENTS.

Cylinder Bushing Mandrel—L. S. & M. S. Ry.

Considerable time is saved by means of the cylinder bushing mandrel shown in detail in the drawing, because of its being self-centering and the bushing is so securely clamped that it is possible to take heavy cuts and run at a higher rate of cutting speed than would otherwise be possible. The jaws are forced outward by tightening the nuts. The bushings are turned at a cutting speed of 30 ft. per minute, with a roughing cut about ¼ in. deep and a 1-16-in. feed and a finishing cut 1-64 in. deep and a ⅜-in. feed. Three sets of jaws are provided to take care of the various sizes of bushings. When the proper jaws are in the mandrel a bushing can be placed on it in about 30 minutes. The time for turning a bushing 21 ins. inside diameter and 40 ins. long averages about 4 hours. The mandrel is heavy enough to carry a 17-in. cylinder with the saddle and has been used for facing off the ends and turning the flanges of cylinders.

KEY WAY MACHINE.

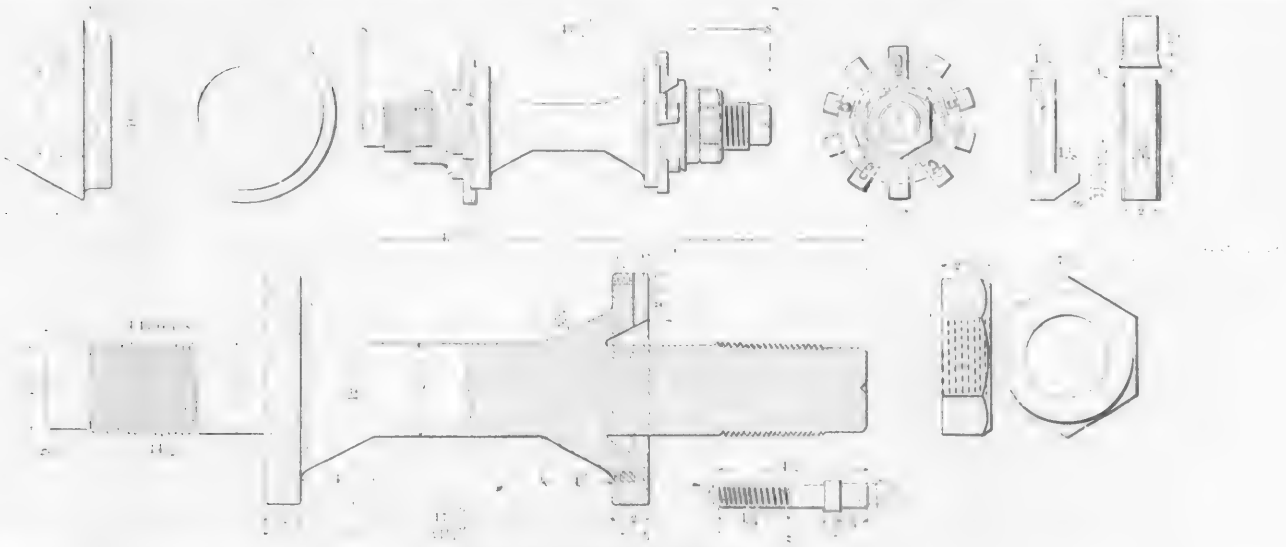
The key way machine shown in the photograph saves about 50 per cent. in time over doing the work with a ratchet drill and cutting out between the holes with a chisel, and about 25 per cent. when a motor is used instead of a ratchet. It also makes a much better job than when dressed by hand. The drill is driven by a No. 1 Little Giant air motor, which is supported by the two arms of the bracket. The vertical feed is obtained by means of the hand screw and the longitudinal feed by means of the ratchet and screw. The machine is held firmly on the axle by means of clamps, as shown. The special form of drill shown in the drawing has been found to give the best results. The key way is laid out by a template and the drill is fed into the work ⅛ of an in. deep at each end and is then moved the length of the key way by the ratchet and screw. The drills are made of Blue Chip steel and 4 key ways can be cut complete in 5 hours; this includes the time for setting up and taking down the machine.

MANDREL FOR ECCENTRICS.

One end of the mandrel shown in the drawing is bolted to the face plate of the lathe. The photograph shows it on the lathe with five eccentrics just being finished. Where four eccentrics are turned at one time about five hours are required for the entire operation, including the mounting and dismounting of the eccentrics on the mandrel. We are indebted for this information to Mr. C. W. Cross, master mechanic at Elkhart, Ind., and Mr. R. B. Kendig, mechanical engineer.

Babbitting Cross-heads.—Chicago & Northwestern Ry.

The method of babbitting cross-heads employed at the Chicago shops of this road avoids the necessity of planing the babbitted surfaces, the babbit being cast in one piece on the cross head in such a way as to leave a satisfactorily smooth finish without planing. The first of the three photographs shows a tilting table, with a small bench beside it. This table, which is of cast iron, has at its center a taper plug to enter the piston rod fit of the cross-head. The cross-head is held in place by a key. At the base of the plug is a cross of sheet metal upon which the cross-head rests. This cross is better shown in the second engraving, which shows the table tilted down. The first two engravings illustrate the angle casting which rests upon the table, and with the cross-head forms the spaces into which the babbitt is poured. The first engraving illustrates the gas heater as applied to the cross-head to warm it up to receive the babbitt. The third engraving shows the angles in place, and held by a hoop with a clamp in position for pouring. The plates held to the angles by bolts in slotted holes prevent the escape of the babbitt at the sides. The gas heater is also used to melt the old babbitt from the cross-heads. This is a very inexpensive plan for doing this work, and the results have been entirely satisfactory.



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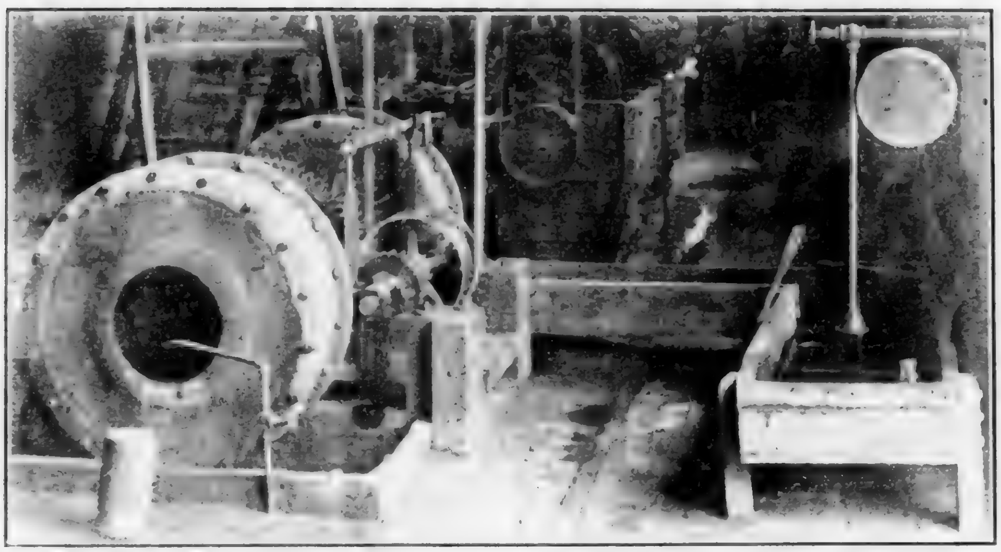

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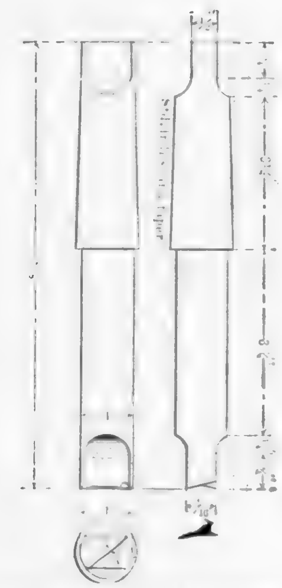

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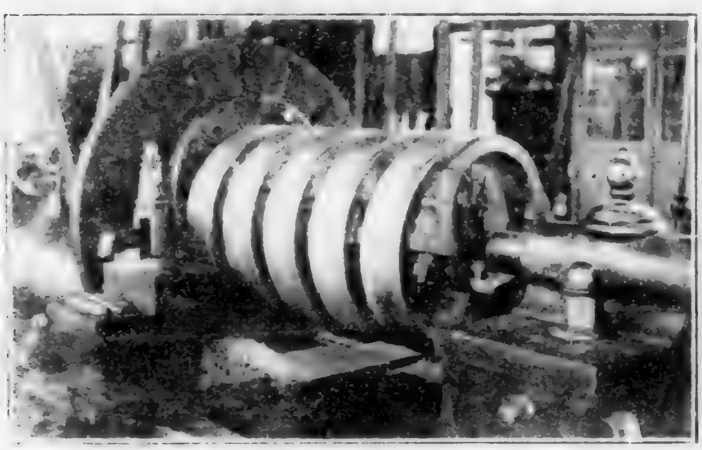

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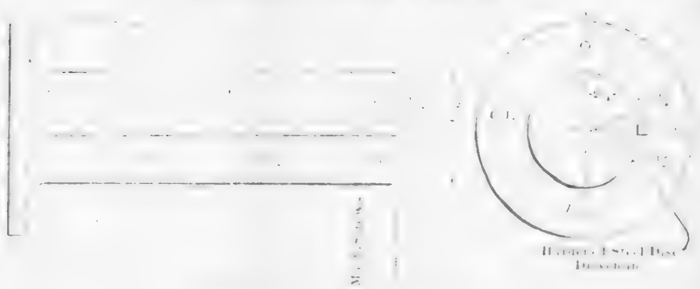

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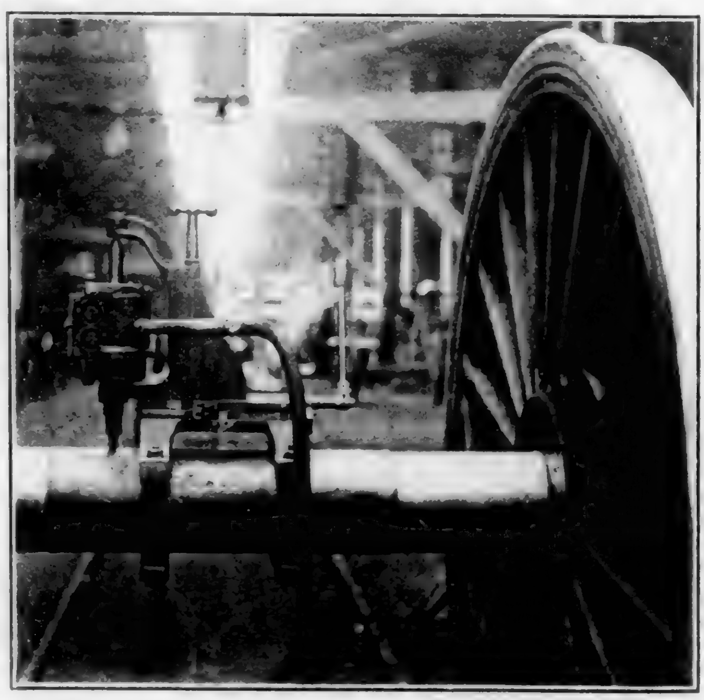

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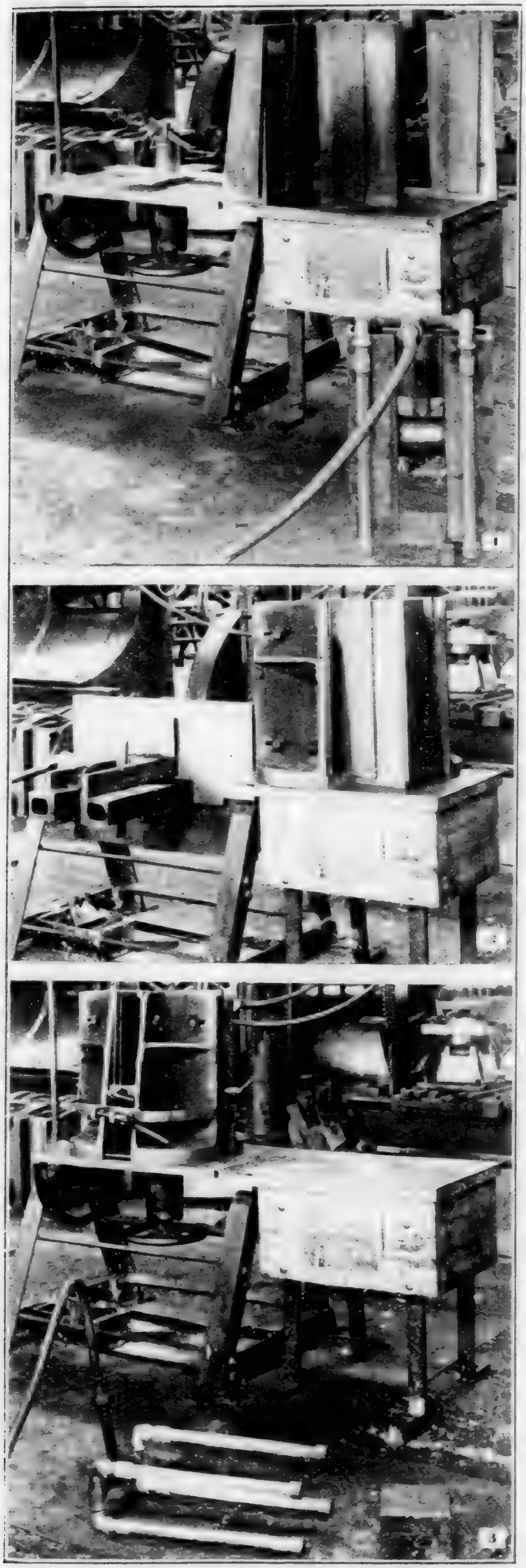

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One end of the mandrel shown in the drawing is bolted to the face plate of the lathe. The photograph shows it on the lathe with five eccentrics just being finished. Where four eccentrics are turned at one time about five hours are required for the entire operation, including the mounting and dismounting of the eccentrics on the mandrel. We are indebted for this information to Mr. C. W. Cross, master mechanic at Elkhart, Ind., and Mr. R. B. Kendig, mechanical engineer.

BABBITTING CROSS-HEADS.—CHICAGO & NORTHWESTERN RY.

The method of babbitting cross-heads employed at the Chicago shops of this road avoids the necessity of planing the babbitted surfaces, the babbit being cast in one piece on the cross-head in such a way as to leave a satisfactorily smooth finish without planing. The first of the three photographs shows a tilting table, with a small bench beside it. This table which is of cast iron, has at its center a taper plug to enter the piston rod fit of the cross-head. The cross-head is held in place by a key. At the base of the plug is a cross of sheet metal upon which the cross-head rests. This cross is better shown in the second engraving, which shows the table tilted down. The first two engravings illustrate the angle casting which rests upon the table, and with the cross-head forms the spaces into which the babbitt is poured. The first engraving illustrates the gas heater as applied to the cross-head to warm it up to receive the babbitt. The third engraving shows the angles in place, and held by a hoop with a clamp in position for pouring. The plates held to the angles by bolts in slotted holes prevent the escape of the babbitt at the sides. The gas heater is also used to melt the old babbitt from the cross-heads. This is a very inexpensive plan for doing this work, and the results have been entirely satisfactory.

CINDER WASHING MACHINE.

While not in the line of a manufacturing machine, the cinder washer, which has been used at the brass foundry of these shops for a number of years, merits attention because of the saving which is effected. About six tons of skimmings and slag are washed in this machine every day, through which the daily saving in brass ranges from $20 to $25. Allowing for the amount of brass which may be picked out of the slag by hand, which need not go through this machine, at least $15 a day is saved by reclaiming metal which would otherwise be lost. The machine consists of a pair of cast iron drums mounted upon the same shaft and driven by a spur gear at the center. The drums are open at the ends. Each drum has a roller made from an old axle, about 9 ins. in diameter, and 1 or 2 ins. shorter than the length of the drum. The purpose of the roller is to crush the material.

A stream of water is turned into the opening into each drum, and the machine stands in a water-tight box. One of the rollers is shown in the engraving. While the machine is in operation a continuous stream of water passes into each drum and the overflow passes into the sewer. The flume shown at the right of the machine is used to wash the crushed material after it is taken from the drums. Strips crossing this flume produce riffles, so that in washing the lighter material, such as coal and coke, falls over and the heavy material is retained.

This machine crushes all the sweepings from the floor, all the skimmings, slag and ashes from the crucible fires—in fact, all the refuse from the brass foundry passes through this machine after being sifted through a coarse screen. The large pieces which will not pass through the screen are crushed with a sledge to about 1½ ins. in diameter, after which they are shoveled into the drums. The rollers crush all the softer material, much of which is washed out by the water. The remainder is shoveled on to the flume, after passing through another screen with ¼-in. meshes. After washing in the flume the remainder is practically clean metal.

We are indebted to Mr. H. T. Bentley, assistant superintendent of motive power, and Mr. Oscar Otto, general foreman of these shops, for the photograph and information.

TIRE TURNING RECORDS.—One of the manufacturers of tool steel in 1897 cited the following as excellent practice in tire turning: Speed of cut, 8 ft. per minute; for 54-in. tires, 2 minutes per revolution; roughing feed, ⅛ in.; finishing feed, ¼ in.; time cutting, 136 minutes; time flanging, 45 minutes; changing tools, 45 minutes; gauging, 10 minutes; finishing cut, 48 minutes; miscellaneous time, 30 minutes; time changing wheels, 45 minutes; total time per pair of wheels, 359 minutes. This is 6 hours per pair of 54-in. wheels. In 1905, eight years later, this has been reduced to 2 hours and 3 minutes for a pair of 84-in. wheels with Krupp tires. The cutting speed, feed and depth of cut have increased, but even in greater ratio have the methods of handling the wheels into and out of the machines improved, and also methods of holding the wheels in the lathe and driving them, so that heavy cuts may be taken without chattering. Improved tool steels have brought many improvements, besides larger and faster cuts. They have tuned up entire shops to a high pitch in handling work. As to tire turning, a pair of 84 in. wheels finished in an hour is the promise made for a new specially designed lathe, which is soon to be built. If this is accomplished, the work will be done in 30 minutes less time than that required in 1897 for changing tools added to that for changing wheels, not to mention the cutting and other items of time.

COST OF FLUE WORK.—In one of the newer railroad shops the editor of this journal was shown through the boiler shop and stopped at a well arranged flue-handling department. On inquiring the cost of the flue work the superintendent replied that he would give no figures of production as the work was then costing him four cents for putting a flue into condition to use again in a boiler. He expected to reduce this cost 100 per cent. and then would gladly give the figures of production. In view of the fact that in some shops this work is costing 25 cents per flue and in other shops 15 cents the modesty of this superintendent is to be admired. His intention to reduce the cost below that of the lowest record in the country is also to be admired, the lowest cost yet reached is believed to be 2½ cents.

CARE OF TWIST DRILLS.—Although the destruction of drills is always great, and may be legitimate even when on an extensive scale, nevertheless, proper methods may be devised whereby considerable saving can be effected without shortening the tool capacity. For instance, a twist drill will drill better, longer, more quickly, and more evenly if it is properly ground, and not ground once in every few days; but if work on it is crowding, every hour or so.—*Mr. R. Emerson, Engineering Magazine.*

RAILROAD SHOP SMALL TOOL EQUIPMENT.—Many shop managers will be alarmed at the prospect of employing not one, but half a dozen to a dozen extra men for supervising and maintaining a thoroughly effective tool system; but it must be remembered that the wages of a few cheap men (and old men are often very careful in such matters) are a small item compared to the time and money saved to the mechanics.—*Mr. R. Emerson, Engineering Magazine.*

PRODUCTION IMPROVEMENTS.—Broadly speaking, the economies that may be brought about in the very first year, by an intelligent analysis of tool conditions, and energetic introduction of method, will be surprising—will seem incredible to those who have not studied actual cases closely. Spending money on men and on the best tools, is one of the wisest forms of retrenchment.—*Mr. R. Emerson, Engineering Magazine.*

TIME ELEMENT IN MANUFACTURING.—The element of time was far less considered formerly than now, because it was of far less value. When wages were low and handwork in vogue, the ratio between the value of materials and of time was the reverse of what it is now, when in many manufactures the time cost exceeds all other costs.—*Mr. Alex. E. Outerbridge, Jr., Am. Academy of Political and Social Science.*

HEATING AND VENTILATION, MACHINE SHOP.

SOUTHERN RAILWAY, SPENCER, N. C.

The total cubical contents of this building aggregates about 4,500,000 cu. ft., and the apparatus for heating and ventilating it includes two special steel plate fans with 9½-ft. wheels 4½ ft. in width, these being placed upon elevated platforms. The lower portion of each fan extends below the platform and the air is discharged through outlets 60¾ x 54¾ ins. in section, inclined upwards at an angle of 45 deg. Each fan is driven by a 10 x 10-in. horizontal center crank engine, supported on a cast iron sub-base. Each heater is provided with 10,528 ft. of 1-inch pipe in the form of the Standard Sturtevant heater section. The apparatus is designed to operate under a steam pressure of 5 lbs. to maintain a temperature of 60 deg. as a minimum when the outside temperature is 10 deg. F. The elevation of the fans upon platforms permits of a gravity return of the water of condensation and also removes the fans from valuable floor space. The special interest of this application centers in the thorough manner of accomplishing the distribution of the air. All discharge pipes lead down to within 10 ft. of the floor, those on the outer walls being carried down in pairs, as it is impossible to secure at this point sufficient area for single pipes. These discharge pipes are recessed into the brick wall, avoiding all interference with the traveling crane. The overhead pipes are kept to the line of the lower chords of the roof trusses, and there is, therefore, no interference with the cranes from any part of the heating system.

PLANER SPEEDS.

In an effort to increase the output the speeds of the machine tools in several railroad shops have been considerably increased. A case recently came under our observation where the speeds for several planers were increased 50 per cent., or from 20 to 30 ft. per minute cutting speed and from 50 to 75 ft. per minute return speed. It was desired to make a still greater increase, for there was no question but what the machines would stand a considerably higher cutting speed than 30 ft. per minute, but this was not done, as it was thought unadvisable to use a higher return speed than 75 ft. per minute since the machines, although in good condition, were several years old.

ACTUAL NUMBER OF FEET CUT PER HOUR ON PLANERS WITH VARIOUS COMBINATIONS OF CUTTING AND RETURN SPEEDS.

Return Speed—Feet per Minute.	Cutting Speed—Feet per Minute. 20	30	40	50	60	70	80	90	100	110
40	800	1028	1200	1333	1440	1527	1600	1661	1714	1760
50	857	1125	1333	1500	1636	1750	1846	1928	2000	2062
60	900	1200	1440	1636	1800	1940	2057	2160	2250	2329
70	933	1260	1527	1750	1938	2100	2240	2362	2470	2566
80	960	1309	1600	1846	2057	2240	2400	2541	2666	2779
90	981	1350	1661	1928	2160	2362	2541	2700	2842	2970
100	1000	1384	1714	2000	2250	2470	2666	2842	3000	3142
110	1015	1414	1760	2062	2329	2566	2779	2970	3142	3300
120	1028	1440	1800	2117	2400	2653	2880	3085	3272	3443
130	1040	1462	1835	2166	2463	2730	2971	3190	3391	3575
140	1050	1482	1866	2210	2520	2800	3054	3287	3500	3696
150	1058	1500	1894	2250	2571	2863	3130	3375	3600	3807
160	1066	1515	1920	2285	2618	2921	3200	3456	3692	3911
170	1073	1530	1942	2318	2660	2975	3264	3530	3766	4007
180	1080	1542	1963	2347	2700	3024	3323	3600	3857	4096
190	1085	1557	1982	2375	2736	3069	3376	3664	3931	4180
200	1090	1565	2000	2400	2769	3111	3428	3724	4000	4258

The accompanying table shows the actual number of feet cut per hour on planers with various combinations of cutting and return speeds. It will be seen that with a cutting speed of 20 ft. per minute and a return speed of 50 ft. per minute the actual number of feet cut per hour would be 857, and an increase of 50 per cent. would bring this to about 1,285 ft. per hour. The suggestion has been made that in the above case the ratio between the cutting and return speeds could have been changed at a small expense by changing the size of the pulleys, and that by leaving the return speed at 75 ft. per minute and increasing the cutting speed 33 per cent., or 10 ft. per minute, the actual number of feet cut per hour could be increased to about 1,565, and still be within the limits of the machine.

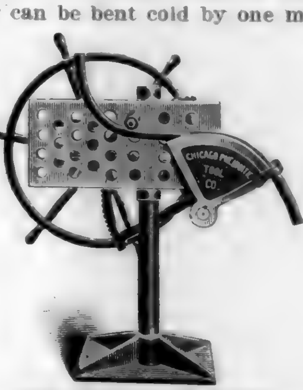
In this connection it might be well to note that in another railroad shop, where remarkable results have been gained towards increased output, some of the planers are operated at a cutting speed of over 50 ft. per minute. These planers are practically the same as those considered above, and as they are standing up well under this heavy duty it would seem that a cutting speed of 50 ft. per minute, for certain classes of work might be used in place of 40 ft., on some of the machines, thus increasing the actual feet cut per hour to 1,800, which is an increase of 15 per cent. over that with a 40-ft. cutting speed, and is twice as great as that originally provided for. Referring to the table, it will be seen that where the rate of cutting speed is less than that of the return speed much greater gains in output can be made by increasing the cutting speed a certain amount than by increasing the return speed the same amount; for instance, with a cutting speed of 30 ft. per minute and a return speed of 60 ft. per minute, increasing the return speed to 70 ft. per minute would increase the feet cut per hour only 60, while increasing the cutting speed to 40 ft. per minute, with a return speed of 60 ft., would increase the feet cut per hour from 1,200 to 1,440, or 240. While in most cases it is not possible to make any very great changes in the return speeds of old planers, as they are about as high as the design of the machines will permit, it is possible to considerably increase the cutting speeds, and a small increase in this direction will materially increase the output.

An inspection of the way the work is being handled on planers in some of the shops would indicate that there is considerable room for improvement in the method of clamping the work to the platen. Cutting mild steel guide bars at the rate of 25 ft. per minute, even with a very heavy cut, is entirely too low, and yet the means provided for clamping these guides in several cases were so poor that the operators were obliged to confess that they were limited as to the amount of feed which could be used when cutting as slow as 25 or 30 ft. per minute. This refers to the design of guides where they are thickest, through the middle and on one side taper towards the ends. The same thing, however, is true of several other kinds of work, and until these methods are improved it will be, of course, impossible to do much towards increasing the output.

Much was said a couple of years ago about the difficulty of driving planers at high speeds with individual motors, because of the high peak in the load at the reversal, but with a heavy pulley on the driving shaft, acting as a flywheel, and with the cutting speeds increased so as to more nearly approximate the return speeds, and with the heavy cuts allowed by the high-speed tool steels the power required at reversal is very little greater than used on the cut, and we find that the machine tool builders have no hesitation in recommending the use of motor drives in such cases.

PIPE BENDING MACHINE.

By means of this machine, illustrated in the engraving and which is very simple in construction, an ordinary helper can easily bend a piece of pipe to any desired curvature in a small proportion of the time required by a skilled mechanic using ordinary devices. Because of its light weight, it may readily be carried about the shop, and can easily be fastened to any column, stanchion or other available support in a few minutes, or it may be furnished with a suitable stand, as shown in the illustration. Iron, steel, brass or copper pipe up to 2 ins. in diameter can be bent cold by one man. Special dies



PIPE BENDING MACHINE.

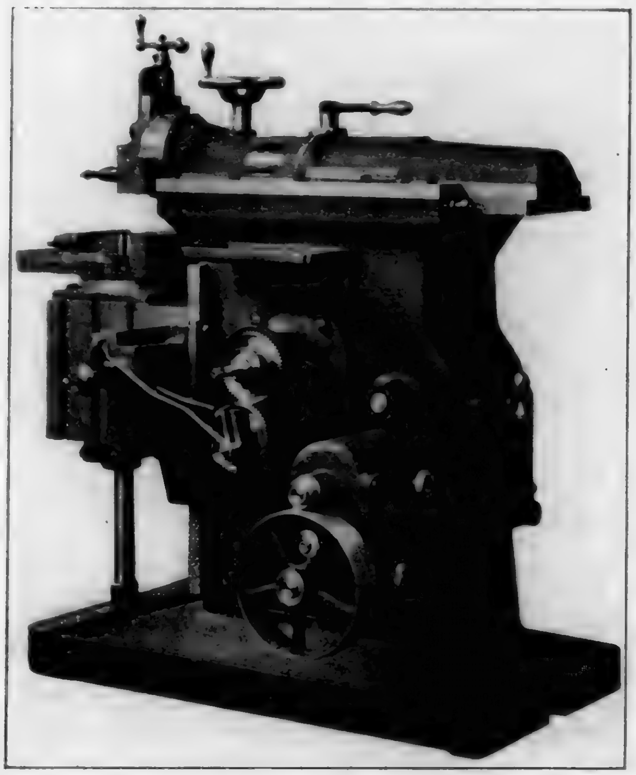
may readily be attached for bending light angles, flats or tee bars to any desired radius.

Galvanized or tinned pipe or pipe coated by the Sabin process may be bent with this device without breaking the coating. It is said that one man, without any assistance, can bend a 2-in. pipe to an S bend in three minutes. The cost of repairs where it has been used 10 hours a day in ship yards and railroad shops, has been very small. This machine has been thoroughly tested in the navy yards, and is manufactured by the Chicago Pneumatic Tool Company of Chicago.

CRANK SHAPER WITH GEAR BOX.

The Cincinnati 16-in. back geared crank shaper, shown in the photograph, is driven through a gear box which furnishes four changes of speed. This arrangement allows the use of a large area of belt contact at all speeds, and change from one speed to another can be made in much less time than where the cone pulley is used. The design of the gear box is simple and strong; it contains three shafts, two of which carry sliding gears which may easily and quickly be moved and locked by means of the two hand nuts shown at the rear of the box. This speed box may be attached to any Cincinnati back geared shaper at any time, though it is preferably done while the machines are in process of construction.

Other notable features of the 16-in. standard back geared crank shaper which is very powerful for its size are the careful and rigid design of the columns; the large bearing for the ram; the deep, heavy and strong design of the rail; the cross feed connecting rod, which is automatically adjustable to any height of the rail and is not dependent upon frictional contact; the outer support for the table, which is carefully designed for maximum efficiency; the elevating screw of telescopic form, which is provided with ball bearings, and is out of the way of falling chips; the vise, which permits straight or tapering pieces to be securely clamped with equal facility and rapidity, and has a graduated swiveling base; the means which are provided for compensating for wear and for the lubrication of the rocker arm; the provision made for the key-seating of shafting and similar work; the fact that the length of the stroke is changed from the working side of the machine, its position is changed by means of the hand wheel at the top of the machine, and either of these changes may be made while the machine is at rest or in motion.



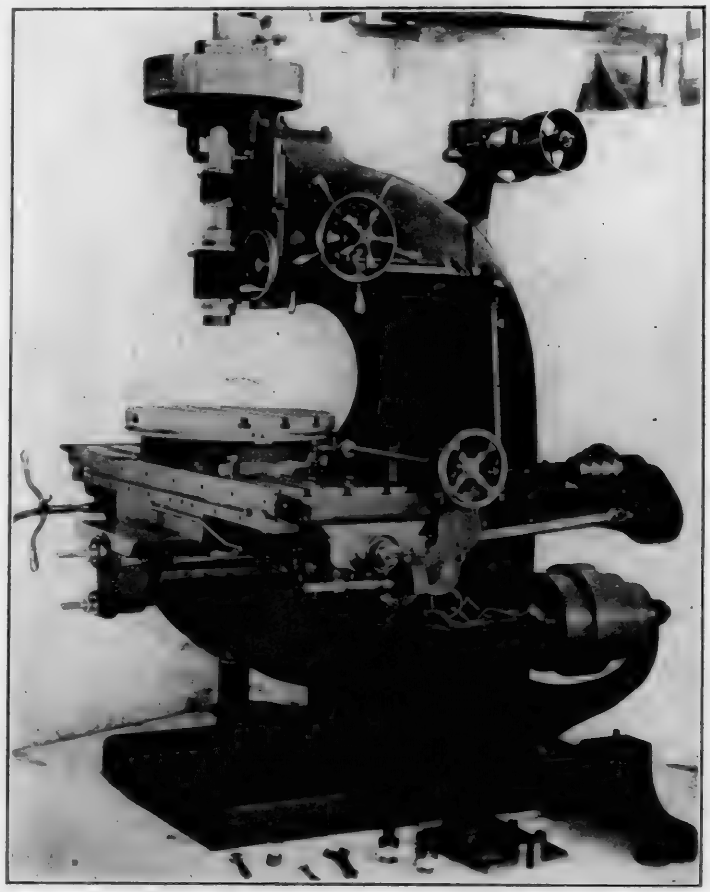
CRANK SHAPER WITH GEAR BOX.

The crank block is a steel forging, and is set well into the cup of the gear, permitting the rocker arm to travel close to the edge of the gear and thus avoiding the usual overhang. Full-length taper gibs, adjustable endwise by single screws, are used throughout. With the back gears in 24 revolutions of the cone shaft are made to one stroke of the ram. This machine is made by the Cincinnati Shaper Company, and its weight, including the countershaft, is about 2,600 pounds.

VERTICAL MILLING MACHINE.

That the railroads are beginning to realize the economies to be gained by the use of the vertical milling machine for certain classes of work and the wide range of work for which it is adapted is evidenced by the increasing number of these machines which are being introduced into the various shops. The accompanying illustration shows a No. 6 Becker-Brainard machine which is the same as the one in the Concord shops of the Boston & Maine Railroad, work on which was considered in connection with the article on "Vertical Milling Machines in Railroad Shops" on page 228 of our June journal. Although this machine was especially designed for a heavy class of work it will handle the lighter and small work to equal advantage.

The vertical movement of the head is actuated automatically by a powerful worm gear. For boring purposes it is provided with an automatic stop which will throw out the feed at any point. It has also a quick return motion. A micrometer stop gauge at the upper left hand side of the head accurately gauges the depth of the cut. The spindle end is threaded to receive large surface mills. Medium cutters are secured by a draw-bar passing through the hollow spindle. The table is ordinarily furnished with a longitudinal feed of 50 ins. The rotary attachment is fed automatically or by hand, with automatic stops for throwing out the feed at each end of the segment. Eight changes of feed are provided. Following are some of the principal dimensions:



BECKER-BRAINARD VERTICAL MILLING MACHINE.

Size of platen inside oil pocket	49 in. x 18 in.
Length of saddle	60 ins.
Longitudinal feed, automatic	50 ins.
Cross feed, with automatic stop	20 ins.
Vertical feed of spindle, automatic	13 ins.
Feed per revolution of cutter	.004 in. to .594 ins.
Range of spindle speeds	9 to 340
Greatest distance between spindle and platen	30 ins.
Greatest distance between spindle and rotary platen	24 ins.
Distance between center of spindle and neck	24 ins.
Vertical feed of knee, automatic	20 ins.
Diameter of spindle, main bearing	3¾ ins.
Diameter of spindle driver	20 ins.
Diameter of rotary table, inside oil pockets, 24 ins.; outside, 27¾ ins.	
Size of hole in spindle	B. & S Taper No. 13

THREE-DRUM SANDER.

The Columbia three-drum, eight-roll sander, illustrated in the accompanying engravings, is economical in operation, and has several important features which enable it to produce a fine and accurate grade of work at a fast rate. The drums which carry the sandpaper are shown in cross-section in Fig. 3, and are equipped with an automatic paper tightener of simple construction, which keeps the paper at an even tension at all times. The machine is thus enabled to turn out a uniform and high grade of work, and the life of the paper is considerably increased. The mechanism is such that it is not necessary to take the cylinders out in order to re-cover them, and this operation is accomplished in one hour.

All parts which require any adjustment or attention are outside of the frame of the machine, and are easy of access, as may be seen by reference to the sectional view, Fig. 3. The oscillators which furnish the reciprocating movement to the drums have a non-cramping arrangement of levers which keeps their lateral movement in line with the axis of the shaft. The oscillators follow the raising and lowering of the cylinders for the changing of the cut with perfect freedom. The longitudinal, cross-sectional view of the oscillator, Fig. 4, shows the self-oiling boxes, the eccentric and strap, the three flexible joints which allow raising and lowering of the cylinders without disturbing the even motion, the collar on the shaft, as well as the outside collar, and the recess in the outside collar for taking up lost motion. The black lines between the collars and the box represent babbitt washers, which prevent wear on the boxes and which may easily be renewed.

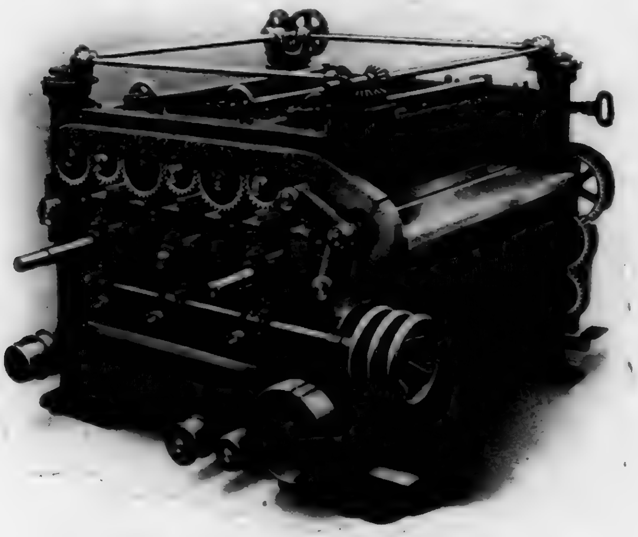


FIG. 1—LEFT-HAND VIEW OF SANDER.

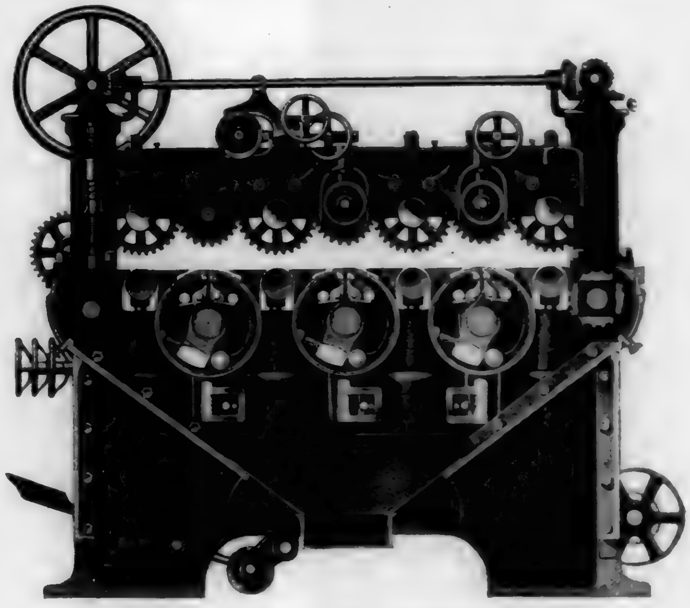
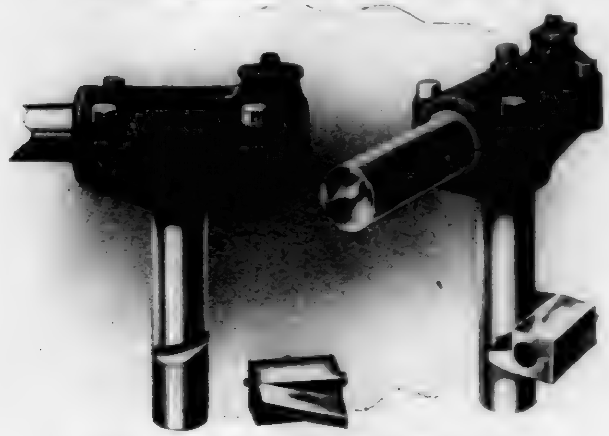


FIG. 3—SECTIONAL VIEW THROUGH CENTER.

FIG. 2—RIGHT-HAND VIEW OF SANDER.



FIGS. 5 AND 6—CYLINDER RAISING DEVICE.

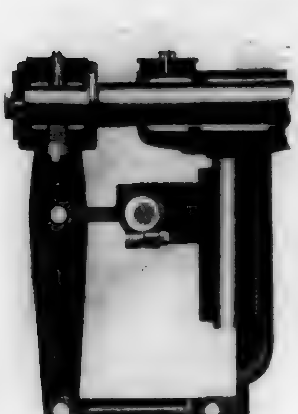


FIG. 4—SECTIONAL VIEW OF OSCILLATOR.

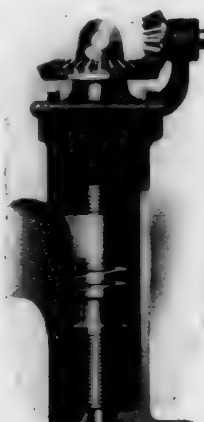


FIG. 7—DETAIL OF SUPPORT FOR UPPER FEED WORKS.

The cylinder raising device is shown in Figs. 3, 5 and 6. This wedge arrangement allows no lost motion, and the cylinders are rigidly supported. The upper feed works is supported by four short screws, with bearings at both the top and the bottom, as shown in Fig. 7. A second nut and a coil spring are provided to take up back-lash in the screws, preventing swaying of the top frame when feeding thick stock.

This sander is the only one which provides for more than one rate of feed. This is done by changing the size of the feed gear just above the step or treadle, shown in the right-hand view. The four gears which are furnished give feeds of 12, 15, 18 and 21 ft. per minute, and it is thus possible to adapt the feed to the finish required. A power hoist for raising and lowering the top feed works is provided, and also an instantaneous feed stop for use in case of accident. The Columbia sander is made by the American Woodworking Machinery Company in sizes from 3 0to 84 ins. in width.

HEAVY DOUBLE AXLE LATHE.

The Niles No. 3 double axle lathe shown in Fig. 1 is remarkable for its simplicity and great power. Sixteen standard axles with 5½ x 10 ins. journals may be rough turned and finished from the forging sizes and the journals may be

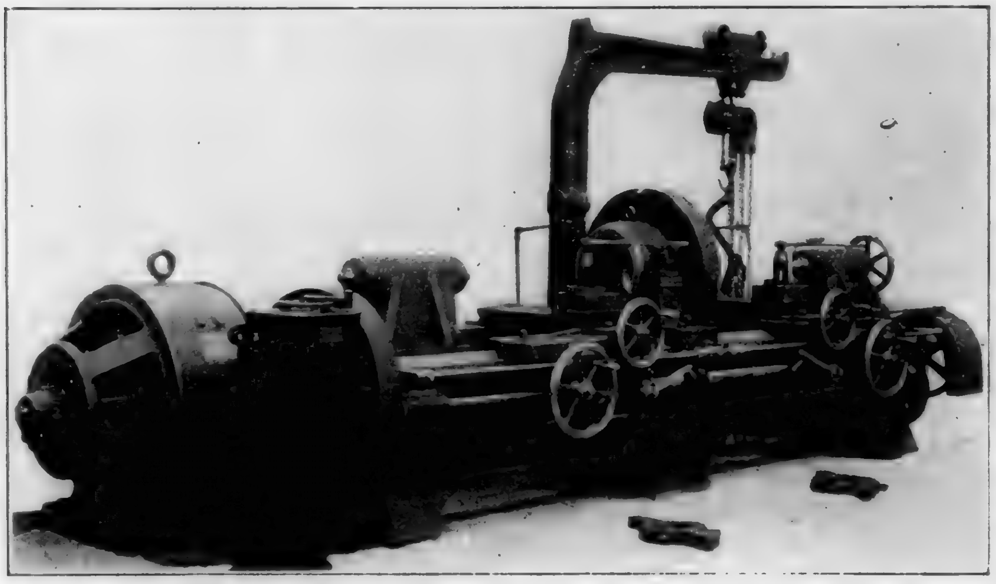


FIG. 1—NILES HEAVY DOUBLE AXLE LATHE—MOTOR DRIVEN.

burnished in 10 hours. It is driven by a 20-h.p. Westinghouse type S motor, which is geared direct to the machine and has a speed variation of 4 to 1. The standard belt drive, shown in Fig. 2, provides six speeds by means of the three step cone for a 6-in. belt and the change gears which furnish the higher speeds for finishing and which may easily and quickly be operated by means of the heavy jaw clutch. The driving cone shaft is well supported by an outer bearing attached to its base plate.

The lathe will take axles up to 8 ft. between centers and has an opening of 12½ ins. through the center head. The sleeve of the driving gear has ample bearing in the fixed head at the center. An improved type of driving dog is used, and to insure true work the face driver has a compensating device to equalize the drive and prevent the tendency to bend the axles. The center head has an adjustment in the bed so that for short work, such as locomotive axles, it may be moved toward the cone end. The tailstocks are massive in design in order to withstand the strain due to heavy cuts. They are adjusted by the handwheel at the right-hand end, and are rigidly clamped in position with 4 heavy bolts.

The carriages have very large bearings on the bed and may be easily and rapidly moved and adjusted. The tool post slide bearing on the carriage is very large to withstand the severe strains due to the burnishing tool action. Provision is made for drawing off and returning the lubricant to the reservoir from which it is pumped. Three positive feeds, 1-12, ⅛ and ¼ in. per revolution, are provided, which may quickly be changed by a pull pin at the right-hand end of the machine. The carriages have rapid hand traverse and an automatic release, which may be operated at any position along the work or to prevent striking the center head.

WESTINGHOUSE FRICTION DRAFT GEAR.—The efficacy of friction draft gear has been shown in severe tests made with a 50-car train loaned to the Westinghouse Air Brake Company by the Pennsylvania Railroad, the tests having surprised a number of railroad officials, invited to witness them, in the extent of the unusual shocks absorbed and in the amount of freedom which friction draft gear gives the engineer in handling his train. Some of the tests which have been made are as follows:

With all slack bunched and the reverse lever in back motion the lever was suddenly thrown ahead and the throttle opened wide. Upon attaining a speed of 20 miles an hour a 10-lb. reduction was made and the brakes released as soon as the speed was reduced to 8 miles an hour, steam being applied to keep the train in motion. This is a severe test, but frequently occurs in practice. With all slack bunched and the brakes fully applied on the seven rear cars the engineer threw forward the reverse lever and gave full throttle. This test showed the power of the friction draft gear to absorb heavy shocks. Another test was to back the train at 8 miles an hour, reverse the engine and apply steam, this representing the extreme of carelessness on the part of the engineer. Another test was a rough start and applying the brakes at a speed of 20 miles an hour by means of the angle cock at the rear car while the engineer used a full head of steam. This produces an emergency brake application starting from the rear end. Another test consists in parting the train back of the fifteenth car, the

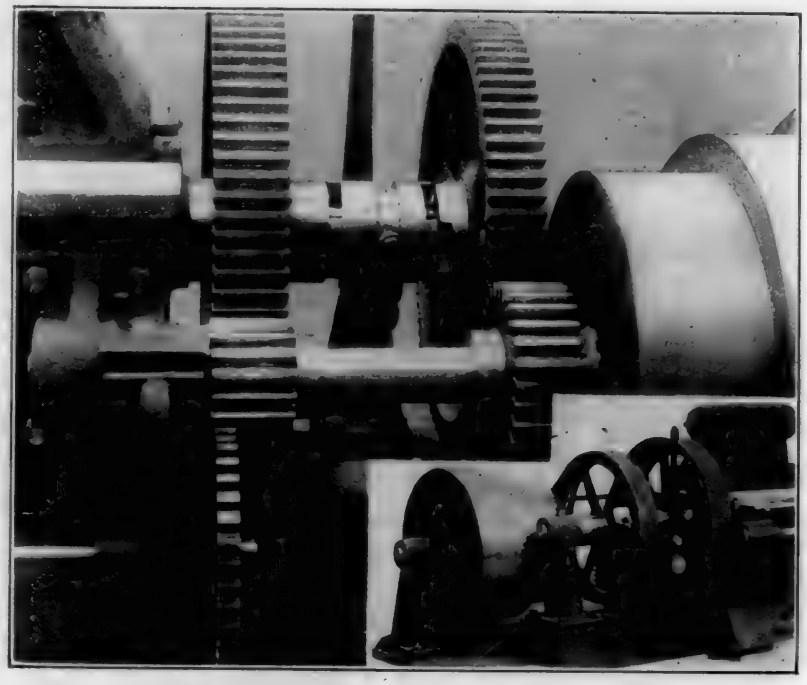


FIG. 2—DETAILS OF BELT DRIVE FOR AXLE LATHE.

forward section backing into the stationary part at speeds of 4, 6 and 8 miles per hour. This test was made to show the slight recoil and the amount of punishment the car will stand. Such tests as these have been made repeatedly in the presence of some of the best known railroad officials, demonstrating the capacity of the gear as far as anything but a service test can demonstrate it.

YOUNG MEN'S CHRISTIAN ASSOCIATION CONFERENCE.—Upon joint invitation of the city and railroad Young Men's Christian Associations of Detroit, the twelfth International Conference of the railroad department of the Young Men's Christian Association will be held in that city September 28th to October 1st. This promises to be the largest and most important gathering which this branch of the association has ever held.

VENTILATOR FOR PASSENGER CAR EQUIPMENT.

The demand for a positive ventilator for passenger car equipment has been such that the Safety Car Heating & Lighting Company have arranged for the manufacture of an improved form of the Andrew ventilator, which has heretofore been applied and is now in service on a considerable number of passenger coaches and is giving most satisfactory results. This ventilator, which is designed for application to a portion of the deck sash openings of a car, is of the exhaust type; operates on the ejector principle, and is automatically reversible, accommodating itself in operation to the direction of the train. Fig. 1 shows in elevation its application to the side deck of a car. It is shown in sectional elevation in Fig. 2 and in sectional plan in Fig. 3.

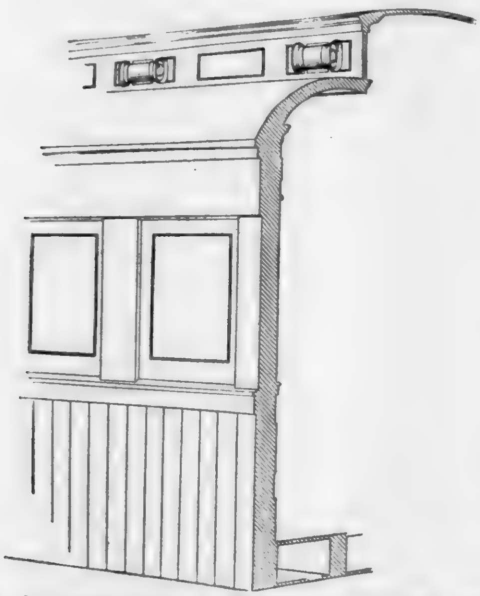
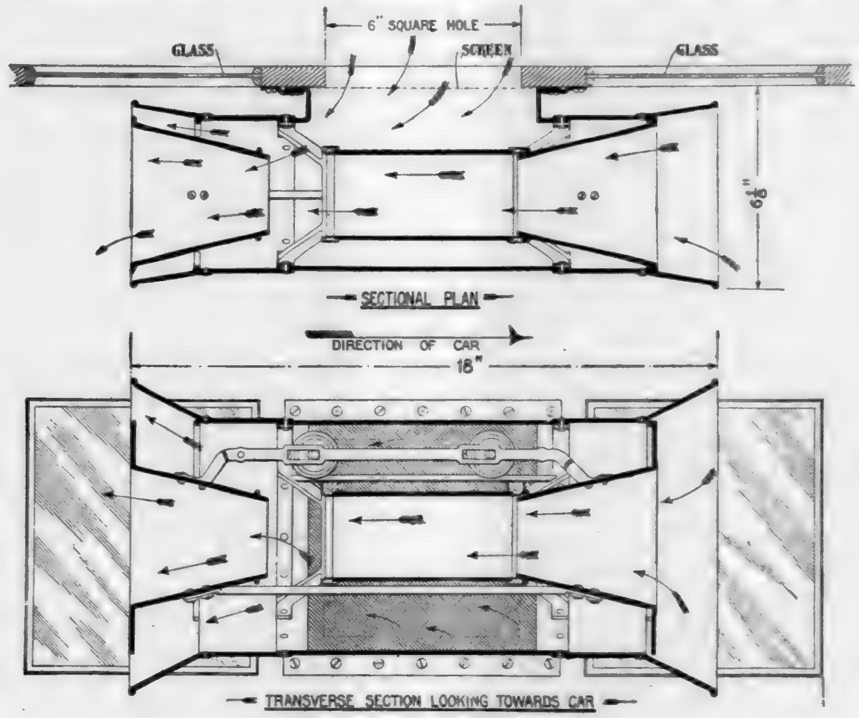


FIG. 1—APPLICATION OF VENTILATOR TO SIDE DECK.



FIGS. 2 AND 3.

It is applied in connection with the deck sash openings, the screen being removed and a frame for the ventilator being substituted provided with glass, except for the 6-in. square screened opening for the ventilator connection. The ventilator thus communicates directly with the interior of the car when the deck sash is open. The deck sashes and their openings which are not fitted with ventilators need no alteration or attention; they may be opened for air supply or left closed. The ventilator is storm proof against transverse storms. The reversal of the ventilators for changes in the direction of the motion of the car is reduced to rolling friction; as a matter of fact, a speed of less than four miles per hour serves to reverse them, and their operation is noiseless. It is not necessary or desirable to apply ventilators to all deck sash openings, but for an ordinary passenger coach, one over each toilet room, and eight connected to the deck sash openings of the main body of the car, are sufficient, while for Pullman cars, one over each toilet room, two over small smoking rooms and four over large smoking rooms, two for each compartment and four for the main body of a twelve-section sleeper are sufficient. Tests show that the average amount of air exhausted by each ventilator at varying speeds is 24 cu. ft. a minute, or 1,440 cu. ft. an hour, and at that rate four of these ventilators applied to a large smoking room (say 6 ft. wide and 8 ft. long) will effect a complete renewal of the air in the room every five minutes.

BUDA REPLACER.

The replacer which the Buda Foundry & Manufacturing Company has recently put on the market has several important features, the advantages of which have been demonstrated by numerous tests. One of these, which is clearly shown in the accompanying engraving, is the groove that protects the flange by allowing the tread of the wheel to first engage the replacer preparatory to mounting. The increase in the friction thus secured is very apparent. The tendency to shove the replacer out of position is also overcome, and there is no spinning of the wheels in the attempt to secure, on the flange alone, sufficient friction to start the ascent.

Another important feature is the reduction of the pronounced and abrupt arch at the ends. This has been accomplished without decreasing the strength required at these points, and the ascent is gradual and easy. The engraving shows how the inner replacer forces the wheel toward the rail. Repeated ex-

CONSTRUCTION OF UNDER SIDE OF REPLACER.

PAIR OF REPLACERS SHOWN IN POSITION.

periments have shown that it is not possible for the wheel to travel over the top of the replacer and drop on the opposite side. Tests made by the Hunt Bureau of Tests show that this replacer will sustain a load more than 2½ times as heavy as any locomotive now in use. The metal is so well distributed, however, that the weight of the replacer is not excessive. The small engraving shows the construction of the under-side of the replacer. Convenient carrying handles are provided. The replacers for 60-lb. rails weigh 150 lbs. per pair, while those for 100-lb. rails weigh 200 lbs. a pair.

A NEW LOCK NUT.

A very simple, practical and positive device, for rigidly locking nuts under all conditions, known as the Burrows patent lock nut, has recently been patented, and is being placed upon the market by the American Lock Nut Company of Boston. This nut lock has been subjected to the most severe tests. which prove that when once locked vibration does not affect it. It may be locked and unlocked an indefinite number of times without injuring the device or the bolt. By the use of these

NEW LOCK NUT.

nuts, which are shown on the accompanying illustrations, a considerable saving of time, labor and material may be effected.

Its mechanical principle is the right-angle contact of two cutting edges. In construction it is a rocking key, set in a slot in the upper surface of the nut, and which intersects the bore of the nut at right angles. In operation, the cutting edge of this hardened key engages the softer threads of the bolt, and the result is to hold the nut rigidly in place.

To operate, see that the nut is unlocked by driving down the outer end of the key until the other end clears the thread, allowing the nut to pass freely on the bolt. When the nut is thoroughly seated, lock by driving down the end of the key next to the bolt.

PERSONALS.

Mr. D. M. Knox has been appointed mechanical engineer of the Denver & Rio Grande with headquarters at Denver, Col.

Mr. H. P. Latta has been appointed superintendent of motive power of the Mobile, Jackson & Kansas City Railway, with headquarters at Mobile, Ala.

Mr. George Dickson has been appointed acting master mechanic of the Chicago, Cincinnati & Louisville at Peru, Ind., to succeed Mr. A. L. Moler, resigned.

Mr. J. M. Wisler has been appointed master mechanic of the Toledo Railway & Terminal Company, with headquarters at Toledo, O., succeeding Mr. H. P. Latta.

Mr. R. W. Burnett has been appointed master car builder of the Erie Railroad, with headquarters at Meadville, Pa., to succeed Mr. Robert Gunn, who is assigned to other duties.

Mr. A. C. Hinckley has been appointed master mechanic of the entire Cincinnati, Hamilton & Dayton, to succeed Mr. Mertsheimer.

Mr. W. B. Page has been appointed master mechanic of the Pennsylvania Railroad at Camden, N. J., to succeed Mr. Rufus Hill, resigned.

Mr. D. D. Robertson has been appointed general master m chanic of the Fort Worth & Denver City Railroad, with offi at Childress, Tex., to succeed Mr. H. C. Van Buskirk.

Mr. F. Mertsheimer has resigned as superintendent of mo tive power of the Cincinnati, Hamilton & Dayton to becom superintendent of motive power of the Kansas City Southern, succeeding Mr. W. E. Symons.

Mr. F. K. Erwin has been appointed construction enginee of the New York, New Haven & Hartford Railroad, with hea quarters in Boston. He is in charge of shop construction an equipment.

Mr. B. A. Worthington has been elected vice-president of th Wheeling & Lake Erie and of the Wabash-Pittsburgh Te minal. He recently resigned as vice-president and genera manager of the Oregon Railroad & Navigation Company.

Mr. Thomas Paxton, heretofore master mechanic of the El Paso & Southwestern Railroad at Douglas, Ariz., has had hi jurisdiction extended over the El Paso & Northeastern System, and has been appointed superintendent of motive powe of these lines.

J. O. Pattee, formerly superintendent of motive power of the Missouri Pacific and previously of the Great Northern, died May 25 as a result of a fall at his home in St. Paul. Since 1857 he has been continuously in railroad service until his retirement from the Missouri Pacific, three years ago.

Mr. George Gibbs, of New York City, has been appointed chief engineer of electric traction for the Pennsylvania, New York & Long Island and the Pennsylvania, New Jersey & New York Railroads. He has resigned as vice president of Westinghouse, Church, Kerr & Company and as consulting engineer of the Interborough Rapid Transit Company and will have charge of all of the electrical and mechanical engineering of the New York terminal work of the Pennsylvania and Long Island Railroads. He will also be consulting engineer of the Metropolitan interests. He will be responsible for the most important and greatest electric traction development of the time.

Mr. J. R. Onderdonk, engineer of tests of the Baltimore & Ohio Railroad, has been placed in charge of the test bureau of that road, which considerably enlarges the scope of his responsibilities, this bureau being responsible for the analysis, inspection and testing, in connection with all equipment materials and appliances bought under specification and all experiments connected with equipment and material are to be made under the direction of Mr. Onderdonk. This includes rolling stock, bridges, cement and other road department material. Mr. Onderdonk is 36 years of age, was "graduated in mechanical engineering at Stevens Institute of Technology in 1889; in 1890 he entered the service of the Baltimore & Ohio as a draftsman, and since January, 1891, he has been connected with the test department, and has for the last ten years served as engineer of tests for the motive power department." He is specially well qualified for the increased responsibilities of the new bureau.

Mr. Edward M. Herr has been elected first vice-president and chief executive, under the president, of the Westinghouse Electric & Manufacturing Company. It is not understood that Mr. Herr will sever his connection with the Westinghouse Air Brake Company, but that he will continue to direct its plans. It is a pleasure to record this further recognition of Mr. Herr's ability, and it is an interesting fact that his experience, which has been found so valuable, was obtained in railroad service. Beginning as a telegraph messenger boy, he has passed successively through the positions of station agent of what is now a part of the Union Pacific, mechanical draftsman, engineer of tests, superintendent of telegraph, division superintendent on the Burlington, master mechanic on the C., M. & St. P. Ry., superintendent of the Grant Locomotive Works,

was sent abroad to establish a locomotive building plant in Russia, returned to this country as manager of the Gibbs Electric Company in Milwaukee, after that he was appointed assistant superintendent of motive power of the C. & N. W. Railway, to be followed by his appointment as superintendent of motive power of the Northern Pacific. He has been with the Westinghouse Air Brake Company as general manager for about seven years, and under his direction exceedingly important improvements in the air brake have been developed. In view of the importance of the thorough knowledge of steam railroad conditions at the present stage of electrical development this appointment seems both fitting and necessary.

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF PAPERS AND REPORTS.

THE USE OF SUPERHEATED STEAM ON LOCOMOTIVES.

By H. H. VAUGHAN.

EDITOR'S NOTE.—It is impossible to properly represent this paper without printing it in full, which lack of space prevents. All who are interested in locomotive practice should procure the paper itself, and study it carefully. It is the best treatment of superheating we have seen, and is the first thorough discussion of the subject as applied to locomotives. There seems to be nothing more important in the immediate future of locomotive progress. The Master Mechanics' Association is to be congratulated on the presentation of this timely and admirable paper.

HISTORY.

The use of superheated steam has rather a peculiar history; unlike the turbine, which lay neglected, with its possibilities unknown, through the years in which the reciprocating engine gradually attained its present state of perfection, superheating was employed and proved its value when the steam engine had already left the experimental stage, when reliable operation had become established, and economy was regarded as a matter of importance. After demonstrating the advantages that could be gained by its use, it was gradually abandoned by the large majority of engineers, and not again resorted to until successive stages of increasing pressure, ordinary multiple compounding, jacketing and refined designing, had been brought to their greatest perfection. When its reintroduction took place, its progress was slow, and years were required to obtain its recognition as a necessity in every plant where power is to be obtained with the greatest economy.

Superheated steam is supposed to have been first applied to locomotives on the Chicago, Burlington & Quincy Railway in 1870, the front tube sheet being set back some distance into the boiler, and the superheater, consisting of a separate cylinder in which the tubes formed practically a continuation of the boiler tubes and into which the steam entered by the dry pipe, and from it passed to the cylinders by pipes connected to the bottom. Such an apparatus could not have actually superheated the steam to any great extent, but it showed some economy which was not, however, considered sufficient to pay for its increase in cost and the trouble of maintaining it, and it was subsequently abandoned. The present development in the application of superheated steam to locomotives is due to Messrs. Garbe and Muller, of the Prussian State Railways, who in 1898 arranged to equip two engines, Hanover No. 74, built by the Vulcan Company, of Stettin, and Cassel No. 131, built by Henshel & Co., the design being prepared by Mr. Schmidt. In a paper read by Mr. Garbe in 1902, before the Berlin branch of the Institution of German Engineers, he related the various reasons that led him to a consideration of the advantages of superheated steam, and discussed in a comprehensive way the benefits derived from its use and the results at that time obtained.

During the present year, 1905, the Canadian Pacific Railway is building fifty-five simple ten-wheel freight engines and six Pacific type passenger engines, which will be equipped partly with the Schmidt and partly with modified Schenectady and other types of smoke-tube superheaters, and a number of other roads are also experimenting with this system, which is therefore fairly well started, experimentally, and is now in sufficiently extensive use to develop its troubles in regular service, and emerge from the nursing stage, which always engenders the suspicion that particular attention to one engine's performance may obtain results that would not be realized from a number.

The theoretical considerations involved in the use of superheated steam have been discussed so thoroughly in various papers and text-books on the subject that any extended treatment of them in this article is superfluous. It is necessary, however, to note certain facts in connection with this question on account of their bearing on the results that have been obtained and the designs of superheaters that are at present in use, and there are, besides, certain conditions in locomotive work which render some results important that do not generally apply in stationary practice.

When water is converted into steam, its temperature depends upon the pressure at which it is evaporated, and in steam, as it is commonly used in the saturated state, these quantities are absolutely dependent, to the extent that any further addition of heat to the boiler does not result in an increase in the temperature of the steam, but simply increases the amount of water evaporated, and, conversely, any abstraction of heat from the steam will immediately condense a portion of it. If, however, the steam, after being evaporated, is still further heated, it becomes superheated, and its volume increases in proportion to its rise in temperature. It is possible to heat steam in such a way that the volume remains constant and the pressure increases with the temperature, but this method cannot be carried out in a superheater, as the pressure is governed by the boiler with which the superheater is necessarily in communication, and consequently remains constant. The amount of heat required to raise the temperature of 1 lb. of steam 1 deg. under this condition is the specific heat of steam at constant pressure, and is not accurately known, although commonly stated to be 0.48, as determined by Regnault. More recent experimenters have, however, assigned to it a higher value, and in an article in *Power* for August, 1904, G. A. Orrok analyzed the experiments of Gruilly, Greissman and others, and showed that it probably varies with the pressure, and that its instantaneous value equals 0.00222t deg.—0.116, where t deg. is the temperature Fahrenheit. This corresponds to a value of 0.65 at 350 deg. and 1.0 at 500 deg., and is slightly higher than the latest determination by Mr. Jakeman, of the British National Physical Laboratory, who found it to be 0.59 between 290 deg. and 420 deg. at 60 lbs. pressure, so that, allowing for a possible increase in the last figure with the temperature, a value of 0.7 may be assumed in connection with locomotive problems, and this figure will be used in this paper where not otherwise noted.

In the case of an engine using saturated steam no heat can be abstracted from the steam to warm up the cylinder walls or steam passages without a sufficient amount of steam being condensed to furnish, by its latent heat of condensation, the heat required. This condensed steam is deposited over the entire surface in a finely divided state, and the larger portion of it remains as water until exhaust takes place, when, owing to the comparatively low temperature at which water is converted into steam at exhaust pressure, it is re-evaporated by absorbing heat from the cylinder walls, which by that time have attained a higher temperature than the exhaust steam. In the process of evaporation the water abstracts heat very readily on account of its close contact with the metal, and while being evaporated it can absorb a large amount of heat without its temperature being raised, about 950 B. T. U. for each pound converted into steam. In the case of an engine using a gas, where no condensation takes place, this interchange of heat is limited to a reduction of temperature during admission, and an increase of temperature during exhaust, of the gases in immediate contact with the walls, and since the heat required to raise or lower the temperature of a gas considerably is very small, the heat abstracted from the cylinder walls during exhaust is correspondingly less. Were 1 lb. of gas the amount affected by this action, it would only require 50 B. T. U. to raise its temperature 100 deg., showing the vastly greater capacity of a film or scattered drops of water to change the temperature of the metal with which it is in contact. The evaporation during exhaust of the water condensed on the walls during admission is the means by which their temperature is lowered, and by avoiding its condensation, their variation in temperature is greatly decreased. Superheated steam, having a temperature higher than that corresponding to its point of condensation under any given pressure, can part with a portion of its heat to the cylinder walls without being condensed, and will, if the superheat be sufficient, avoid it entirely, thus approximating the condition of an engine working with a non-condensable gas.

In an engine operating with saturated steam, there is, in addition to that shown on the indicator diagram as present in the cylinder, a quantity of steam passing into the cylinder at each stroke, which condenses into water during admission, and is re-evaporated during exhaust without performing any useful work; while, if sufficient superheat is employed to render the steam dry at cut-off, all the steam that has passed into the cylinder is that shown on the diagram, the heat absorbed by the cylinder walls being furnished by its drop in temperature in place of by condensation.

When steam is superheated beyond the point at which dry steam is present at cut-off, a still further gain occurs on account of decreased heat interchange up to the point where it is dry at release, which requires an increase in the superheat of from 50 deg. to 100 deg., according to the rate of expansion and other conditions, and in stationary practice, where an economical rate of expansion is invariably employed, superheating is rarely carried to this point. In locomotive work, however, engines are commonly worked at long cut-offs for considerable distances, and in such cases it is exceedingly likely, when the steam is considerably superheated, that superheat may occur at release. This is not a loss, as commonly stated, but is a gain due to the second advantage mentioned, that of a working fluid which may be used at high temperatures without excessive pressures.

By superheating, the temperature, and consequently the volume, can be increased considerably without increasing the pressure; thus, for steam at 200 lbs. (abs) superheated 200 deg., the P V divided by heat of production is 0.425, a gain of nearly 11 per cent. by superheating. This gain, which may be termed the economy due to volume, as contrasted with the economy due to temperature, which acts through the reduction of cylinder condensation, is evidently most effective when steam is used non-expansively or at long cut-off, whereas, the avoidance of waste in the cylinders is not important under those conditions, but operates when the rate of expansion is greater, and considerable loss would occur in an engine using saturated steam. The economy due to volume is obtained through the increase in the volume of steam when superheated, which enables a given weight of steam to provide the volume required for a greater number of strokes of the engine, and it is evident that the economy from this cause commences when the steam is dry at cut-off, and continues when superheat is present at release.

The conclusions to be drawn from these results are that, in locomotive work, should conditions be such that superheat occur

at the exhaust, no loss, but, on the contrary, a gain, is obtained; that this gain, while very valuable at long cut-offs, becomes of less importance as the cut-off is shortened, and a more important economy is then obtained through the avoidance of similar condensation. Since the economy obtained from volume is only 10 per cent., with a superheat of 200 deg., under favorable conditions, while that obtained from temperature may amount to 25 to 30 per cent., the latter is by far the most important, and while economies may be obtained at long cut-offs, the greatest will occur with expansive working.

EDITOR'S NOTE.—The paper at this point presents illustrated descriptions and discussion of all of the well-known arrangements of superheaters as applied to locomotives. This feature of the work must be omitted for lack of space.

RESULTS.

The results obtained from superheating appear invariably to have shown a decided economy. Starting with the instance previously referred to as reported by Trevethick, in which an economy of 30 per cent. was obtained with an unknown degree of superheat, but in which 7 per cent. of the total coal burned was used in the superheater, all of the various tests show a remarkable agreement in results. A short statement of a number of experiments, which follows, is interesting as showing a general agreement among a number of investigators.

EDITOR'S NOTE.—The results accorded include foreign as well as American figures. This abstract includes only the results obtained upon the Canadian Pacific Railway.

Turning from the results obtained abroad to those in America, the only figures so far available are those on the Canadian Pacific Railway, and on this road the records available are those obtained in service over a considerable period. These results, after all, must be the deciding ones, as in view of the influence of the boiler efficiency on the net economy, isolated tests will always be more or less unsatisfactory. It is possible to determine the water consumed per unit of power developed with considerable accuracy, but in determining the water evaporated per pound of coal, a factor must be taken into account that is independent of the boiler, and pretty near everything else on the road, in the efficiency of the fireman. It is quite possible, on a test, to obtain an evaporation that is decidedly better than that realized day after day in service, and while no doubt careful tests are desirable, and it is the intention to carry them out as soon as a dynamometer car is available for the purpose, yet the service results are so far satisfactory and are interesting as showing the economy actually obtained.

The records from engine No. 548 extend over a period of seventeen months, during which time this engine was compared with similar simple and Vauclain compounds in freight service and with simple and two-cylinder Pittsburgh compounds in passenger service. The dimensions of the various engines are as follows:

These engines were compared for periods in which they were running in corresponding service to No. 548 between Montreal

	Engine	No. of Class Running	Ton-Miles, Thousands	Total Coal, Tons	Coal per 1,000 E. G. Ton-Miles	Relative Economy	1600 to 1621
Chalk River to North Bay.							
January	1200	12	7,077	717½	202	100	21
	1300	1	805	80¼	199	98	
	1600	5	5,111	410½	160	79	
	1621	9	10,669	1,075	201	100	
February	1200	1	202	17½	173	100	14
	1300	1	1,354	117¾	173	100	
	1600	8	7,542	612¾	162	93	
	1621	8	8,728	824¼	188	108	
March	1200	1	316	24½	155	100	13
	1300	1	770	56	145	93	
	1600	6	6,175	423¼	137	88	
	1621	6	7,095	560¼	157	101	
April	1600	5	6,179	374¾	121	93	7
	1621	6	9,886	645¼	130	100	
North Bay to Cartier.							
January	1200	10	6,393	499	156	100	4
	1300	1	713	48⅓	136	87	
	1600	4	2,008	146	145	93	
	1621	6	9,307	708¼	152	97	
February	1200	2	1,590	137½	172	100	16
	1300	1	565	44¼	156	91	
	1600	6	6,043	423¾	140	82	
	1621	8	5,052	429	167	97	
March	1200	3	1,377	100¼	145	100	14
	1300	1	728	50	137	95	
	1600	5	4,825	294	121	83	
	1621	6	5,360	378¼	141	97	
April	1200	1	365	26	143	100	8
	1300	1	191	9¾	102	71	
	1600	5	6,322	367½	116	81	
	1621	6	5,599	352¾	126	88	
Chapleau to White River.							
January	1300	3	3,755	340½	181	100	25
	1600	13	13,956	1,267¾	181	100	
	1621	5	612	74½	243	132	
February	1300	4	2,696	239	177	100	
	1600	9	13,226	1,050¼	158	89	
March	1300	3	4,821	400¼	164	100	
	1600	10	19,106	1,348	141	86	
April	1300	4	2,518	193	153	100	
	1600	9	11,894	738¾	124	81	
Cartier to Chapleau.							
January	1300	3	3,373	322¾	191	100	13
	1600	11	14,547	1,209¼	166	87	
	1621	7	1,170	110⅓	188	98	
February	1300	3	3,979	332¾	167	100	
	1600	9	13,176	996¾	151	90	
March	1300	3	3,305	246¼	149	100	6
	1600	11	21,942	1,450	136	91	
	1621	1	265	17	128	86	
April	1300	3	2,726	204¾	150	100	
	1600	9	12,814	766¾	119	79	

Engine No.	548	616	595	634	482
Type	4—6—0	4—6—0	4—6—0	4—6—0	4—6—0
Kind	Simple S. H.	Simple.	Compound	Simple.	Compound.
System	Schmidt S'box.	....	2-cylinder Pittsburg	....	4-cylinder Vauclain.
Cylinders	18 x 24	18 x 24	20 & 30 x 24	18 x 24	13½ & 23 x 24
Drivers	62 ins.	62 ins.	62 ins.	62 ins.	62 ins.
Heating surface, fire tubes and firebox sq. ft.	1,116	1,291	1,291	1,428	1,614
Grate area	23.44	23.44	23.54	28.54	28.54
Boiler pressure, lbs.	180	180	180	180	200
Weight on drivers, lbs.	96,800	95,400	96, 800	94,350	94,100
Total weight, lbs.	124,000	119,250	123,400	119,325	129,225
Superheating surface, sq. ft.	307				

	Engine.	Engine, Miles.	Ton-Miles, Thousands.	Coal, Tons.	Coal, per 1,000 Ton-Miles.	Relative Economy.
May, 1903, to December, 1903	548	34,493	33,183	1,541¾	93	81.5
Freight	482	31,857	30,457	1,741¾	114	100.
January, 1904, to May, 1904	548	16,812	14,404	931	129	74.
Freight	616	15,722	13,248	1,167	176	100.
June, 1904, to September, 1904	548	15,768	2,451	467¾	382	81.5
Passenger	595	16,128	2,560	600	469	100.
	634	16,854	2,750	680¼	495	105.

Engine No.	1000	996 and 997	1300	1319
Type	4—6—0	4—6—0	4—6—0	4—6—0
Kind	Compound S. H.	Compound	Compound S. H.	Compound
System	2-cyl. Schmidt fire tube	Pittsburgh 2-cyl.	2-cyl. Schenectady, fire tube	2-cyl. Schenectady,
Cylinders	22 and 35 x 26	22 and 35 x 26	22 and 35 x 30	22 and 35 x 30
Drivers	63 ins.	62 ins.	62 ins.	62 ins.
Heating surface, fire tubes and firebox, sq. ft.	1,888	2,420	2,492	3,065
Superheating surface, sq. ft.	350	....	390	....
Grate area, sq. ft.	33.02	33.02	44.08	44.08
Boiler pressure, lbs.	210	210	200	200
Weight on drivers, lbs.	129,000	128,000	141,000	141,000
Total weight, lbs.	172,000	169,000	192,000	190,000

and Smith Falls, a practically level division, with rolling grades with a maximum of 0.5 per cent., and the results were as follows: the column marked "Relative Economy," in each case showing the amount of coal consumed by engine No. 548 as compared to the engine with which it was tested. (*See table on page 272.*)

Noting that Nos. 616 and 634 are simple engines and Nos. 595 and 482 are compounds, these results show satisfactory agreements, and would show that this engine consumed about 75 per cent. of the coal required by a simple engine, and 82 per cent. of that required by a compound in similar service. The superheat obtained in this engine is, however, high, running from 550 deg. to 650 deg., according to conditions, and it may be considered as representing the extreme limit to which superheating can be conveniently carried. There is no doubt that the results that have been obtained are exceptionally economical, and the engine has been a favorite with the men handling it in any service. The valve and cylinder arrangements of this engine were designed by Mr. Schmidt and have given entire satisfaction at the temperature mentioned above, although when the superheat was raised above 700 deg. a certain amount of trouble was experienced with the lubrication and packings.

The results from engines 1000 and 1300 extend over a period of nine and eleven months, respectively, during which time these engines were compared with engines identical in every respect except that of not being equipped with a superheater. The dimensions of these engines are given at the foot of page 272.

Engine 1000 was compared with Nos. 996 and 997 for periods in which they were running in corresponding service between Montreal and Smith Falls in freight service. Engine 1300 was compared with No. 1319 in corresponding service between Chalk River and North Bay, and North Bay and Cartier; these divisions are very similar, Chalk River to North Bay being an undulating road with several grades four to seven miles long, with occasional stretches of 1 per cent., but more generally 0.6 to 0.8 per cent., the total rise on the division being 135 ft. From North Bay to Cartier the road is undulating, except for one rise of 480 ft. in sixteen miles, the limiting grades being 1 per cent. and the total rise 230 ft. The results were as follows, arranged as for engine No. 548:

	Engine	Engine, Miles	Ton-Miles, Thousands	Coal, Tons	Coal, per 1,000 Ton-Miles	Relative Economy
Montreal to Smith's Falls.						
January, 1904, to July, 1904	1,000	21,567	25,321	1,271½	100	72
	997	19,662	23,278	1,499¾	129	100
August, 1904, to September, 1904	1,000	3,740	4,657	188½	81	70
	996	5,666	7,026	409¾	116	100
Chalk River to North Bay.						
November, 1903, to September, 1904	1,300	22,987	17,075	1,127½	132	90
	1,319	19,983	15,091	1,112⅕	147	100
North Bay to Cartier.						
November, 1903, to September, 1904	1,300	10,964	9,887	550⅓	111	84
	1,319	10,521	9,249	616⅓	133	100

These results are rather more favorable to the superheater engines than would have been expected, especially in the case of engine 1000, where it will be seen that this engine gave considerably better comparative results than No. 1300. These engines also being equipped with the smoke-tube type of superheater, did not obtain the same degree of superheat as No. 548, generally running from 500 deg. to 550 deg. There was a certain amount of leakage from the boiler of 1000, 996 and 997 class during the period, which makes the comparison of less value than those for 548 and 1300, but in spite of this the results are evidently satisfactory.

The results from twenty Schmidt smoke-tube superheaters and twenty-one Schenectady superheaters have been obtained over a period of four months.—[See original paper for these figures.—EDITOR.]

GENERAL CONCLUSIONS.

The use of superheated steam does not entail the multitude of practical difficulties that so generally accompany any invention or improvement that is introduced to improve the economic results obtained from a locomotive, and, indeed, it is probable that as experience with its application develops, some of the expenses that are incurred in the locomotive of to-day will be diminished rather than increased. There would only appear to be two possible sources of additional cost, the wear of valves and cylinders due to defective lubrication, and the cost of maintaining the superheater itself. So far as has been learned at present, the lubrication of superheater engines is not different from that of other engines, with the exception that the lubrication must be accomplished, and it is not sufficient to hope that the oil gets to the designed spot. For this purpose a positive feed lubricator is required, and this should preferably be provided with six feeds, so that pipes may be led to each end of the valve and to the cylinder. It should also be possible to vary considerably the amount of oil fed per minute, as superheater engines, even more than those of the ordinary type, require more oil when working slowly at long cut-offs than at other times, on account of the high temperature of the steam being maintained throughout the stroke. This can be effected either by supplementary oiling or by an easy adjustment

	Engine	No. of Class Running	Ton-Miles, Thousands	Total Coal, Tons	Coal per 1,000 E. G. Ton-Miles	Relative Economy	1600 to 1621
Megantic to Farnham.							
January	1200	6	759	124¾	328	100	
	1621	7	13,5[illegible]5	2,164½	318	97	
February	1200	4	8[illegible]9	1[illegible]¼	403	100	
	1621	7	12,639	2,060½	326	81	
March	1200	1	170	32	378	100	
	1621	8	15,481	2,153¼	278	74	
April	1200	1	1,033	152¼	295	100	
	1621	8	13,923	1,820¼	261	89	
Farnham to Outremont.							
January	1200	8	1,120	126¼	225	100	
	1621	4	1,800	186	206	92	
February	1200	4	1,754	211	240	100	
	1621	7	801	105½	263	109	
March	1200	2	1,228	112½	183	100	
	1621	3	821	83	202	110	
April	1200	1	49	5½	224	100	
	1621	1	52	6	230	102	
Newport to Farnham.							
January	1200	4	611	102¼	334	100	
	1621	6	1,807	261¼	289	87	
February	1200	2	946	137	289	100	
	1621	4	1,184	177¾	300	104	
March	1200	2	1,036	148¼	286	100	
	1621	1	282	37¼	264	92	
Brownville to Megantic.							
January	1200	12	5,364	677	252	100	
	1621	6	12,113	1,429¾	236	94	
February	1200	12	6,991	982½	281	100	
	1621	6	4,686	801¾	342	122	
March	1200	12	7,907	949¼	240	100	
	1621	4	9,447	1,064	225	94	
April	1200	14	6,319	720¼	228	100	
	1621	4	7,837	923½	235	103	

of the lubricator, allowing a large amount of oil to be fed at low speed, but the latter will be preferable if obtained without complication. With proper lubrication there appears to be no additional wear of valves or pistons, and while a special mixture of metallic packing must be used, it has given, if anything, less trouble on the superheaters than on the other engines. On engine 548, in which the steam was superheated as high as 700 deg., it was found that the ordinary valve oil was not suitable, and that the rod packings would melt out, but by reducing this from 550 deg. to 600 deg., these troubles were not experienced, and no difference is noticed between an operation of this and an ordinary engine. The valves used on the 548 are Mr. Schmidt's design, but with split ring packing in place of the solid ring used in Germany, so that they are practically similar to the piston valves in general use, except in their being of small diameter, 6 ins. for an 18-in. cylinder, and double ported. The packing rings, in place of being narrow, are comparatively wide, and on the surface there are several water grooves. These rings have given exceedingly good service, but in view of the successful use of split rings it is difficult to see any reason why valves of the ordinary design should not be entirely suitable for superheated steam, the only point to consider being whether small double ported valves would not be preferable to the large single ported valves at present in use, and whether wide rings with water grooves would not give better results than narrow plain rings. It is natural that, on account of the reduced weight of the superheated steam, a smaller admission area can be used than that required for saturated steam, but for equal flows under equal heads, the rate is only 10 to 9 and 8, for steam superheated 100 deg. and 200 deg., respectively, so that the dimensions adopted by Mr. Schmidt must be entirely ascribed to the use of double ported valves. Those engines on the Canadian Pacific having smoke-tube superheaters which have not developed the same degree of superheat as engine 548 have given, so far, no trouble with their valves, pistons and packing, when properly lubricated, and while there is room for considerable improvement in positive feed lubricators before an entire suitable design is obtained, it is safe to say that with proper lubrication there will be no greater expense in maintaining the engine on account of using superheated steam.

The repairs to the superheater proper are at present difficult to determine; the smokebox superheater certainly entails an additional expense when flues are renewed, as it has to be entirely dismantled in order to get at the tube sheet, but while it is said to have given some trouble in service in Germany, such has not been the case in three years' experience on the Canadian Pacific Railway. Some trouble was at first experienced with the joint between the large tube and the back tube sheet, but this was overcome by properly thinning the edges of the lap, as in firebox construction. There has been no leakage from the various joints in the front end and, in fact, so far nothing has developed that would lead to any additional expense in maintenance.

The smoke-tube superheaters of the Schmidt type have given no trouble in service, but the arrangement of bolts and clips for securing pipe flanges to the headers is inconvenient, and it is quite difficult to make the joints perfectly tight to commence with; once tight, however, they do not appear to develop leakage, and it seems probable that by the independent bolting now arranged for there will be no difficulty in this respect. In the Schenectady type there has been no trouble with the headers, but the ends of the superheater pipes toward the firebox have blistered in a number of cases, due to the dampers not operating properly and allowing the pipe end to become overheated; this has been overcome by welding a solid plug into the end of the pipes, which should remedy the defect as in the Schmidt design, in which steel return bends are used; this action has not developed, as the metal is suffi-

ciently thick to stand a considerable temperature without deforming when steam is admitted. The dampers must, however, be kept in an operative condition, as otherwise, when the blower is applied with a hot fire immediately after shutting off, the pipes may be subjected to an intense heat which is unsafe in view of their containing no steam. The 5-in. tubes have not been giving any especial trouble; in fact, they have lasted as well as the smaller tubes; this applies, of course, to good water districts, and there is no available experience to determine whether, on bad water, they would stand up until the other tubes need renewal, but it is evident that their position in the flue sheets is favorable and the circulation around them is better than around the more closely spaced fire tubes.

As a matter of fact, it is too early yet to say anything definite about the expense of maintenance of superheaters; there is, of course, a possibility of a comparatively rapid deterioration of the pipes occurring, but there does not appear to be any immediate expense that will develop in one or two years' service. On the other hand, there is the advantage of decreased evaporation for the same work, that occurs in compounds on acount of their increased efficiency, and there is also an advantage in the dryness of the steam and reduced liability of water in the cylinder. On the smokebox superheater with its high superheat, it is almost impossible to work water over into the cylinder, excepting when first starting out before the apparatus has been warmed up, and while this is not the case to the same extent with moderate superheaters, it is an advantage to a certain degree.

A possible advantage of superheating has not been utilized in its application in America, namely, a reduction in boiler pressure without loss in efficiency, although in Germany this has been usual. There is no doubt that the increase of pressure from 175 to 200 and 210 lbs. that has taken place within the last few years has been of doubtful advantage. While there is a gain in economy, this is accompanied by an increase in the losses due to leakage, both in engine and boiler, and by a considerable increase in the cost and trouble of boiler maintenance. By superheating, the initial pressure becomes of less importance, and with the proper amount of superheat it will be possible to return to pressures of 175 lbs. or less without any appreciable loss in economy, and with a relief from those boiler troubles, which have become more serious as the pressure has increased, it is probable that the saving from this cause alone will overbalance any additional expense connected with the maintenance of the superheater.

Herr Garbe, in addition to the reduction of boiler pressue, advocates a still further advance, namely, the enlarging of the cylinders sufficiently to develop the full power of the engine, with cut-offs of 30 to 33 per cent. A reduction in power is then effected chiefly by throttling, the cut-off remaining practically constant. This method may possibly prove advisable in American passenger work, but it does not appear practicable for freight locomotives. It is evidently impossible to develop the same tractive power with a given weight on drivers, with a cut-off of 30 per cent. as with 80 per cent., since there is a greater variation in the maximum effort in the former case, and with the conditions here prevalent, where the loading is so closely equal to the capacity of the engine, a reduction in capacity could not be tolerated. A reduction in boiler pressure, however, when accompanied by a corresponding increase in the cylinder dimensions, does not affect the tractive power, and would appear to be a decided advantage.

In general, therefore, it may be assumed that the maintenance of locomotives using superheated steam will not be necessarily greater than that of ordinary locomotives of similar size, as although certain additional expenses are introduced, these are offset by economies in other directions, and the net result will not be very much different. If this position is correct, the advisability of superheating depends entirely on the relation between the initial additional cost and the saving obtained, and as, at present, the cost of applying a superheater is about $1,000 per engine, and the tendency will be rather to reduce this amount than increase it, it is evidently a very good investment. A 200,000-lb. freight engine making 30,000 miles per annum will burn about 2,500 tons of coal, which, at $2 per ton, costs $5,000, so that evidently a saving of 10 per cent. will pay 50 per cent. of the additional cost per annum, and it appears perfectly safe to state that with a superheater at least that amount can be saved. While slightly more expensive, at first cost, than compounding, there is in the application of superheated steam a possible development in locomotive engines, which obtains at least as great an economy in fuel, which is practicable and without complication in its construction, which costs no extra for maintenance, does not reduce the efficiency of a locomotive in any way as a mover of freight, and which, without any desire to appear too enthusiastic, certainly promises to become one of the greatest steps in the direction of economy that has been introduced for many years past.

Proper Loading for Locomotives.

Committee—C. H. Hogan, H. T. Herr, D. F. Crawford, H. T. Bentley.

This report contained the opinions of a number of individual members as to the essential factors in loading locomotives, and presented a number of references to treatment of the subject in the technical journals. A feature of value lies in references to special articles devoted to this subject.

The important factor underlying the proper loading of locomotives is the length of time which may be used in hauling a train over a controlling section of the road; this controlling section may be an opposing grade, a stretch of single track in an otherwise multiple track line, distance between sidings, etc. As the time may be longer, or shorter, so may the loading of the locomotive be heavier, or lighter. The length of time having been fixed, the next two important factors are the power of the locomotive and the resistance of the train and the items which, in opinion of the members, affect these factors as quoted below.

The power of the locomotive may be calculated with a reasonable degree of accuracy, but without knowing the peculiar conditions of each case it will be impossible to say what allowance should be made for the condition of the locomotives, for the water, the fuel and for the almost innumerable items, some of which need attention in each locality.

The train resistance contains a greater number of variables than enter into the calculations of the power of the locomotive; the number of cars, and their condition, track conditions, atmospheric conditions and others. When the rating is very accurate the total tonnage should be ascertained by more accurate means than those prevailing at the present time in many places.

There is a means of checking the calculations of locomotive power and of train resistance—the dynamometer between tender and first car in train, and it is recommended that this be used. Calculations are very well, but it frequently happens that the basis of the calculations is wrong. For instance, the grades may not be what the profile data show; the elevation on curves may have more serious effect than assumed; the resistance per ton and per car may differ from the assumptions, and the locomotive may give results different from the assumed ones.

The operating department and the motive power department ought to take equal interest in the proper loading of locomotives.

Immediately below are given the factors which the members think affect the economical loading of locomotives, and considering the innumerable combinations of them which are possible, not only on different roads, but also on different sections of the same road, the committee thinks that it cannot treat of the subject of the report in other than the very general way given in the forgoing. The name of the member making reply and the railroad with which he is connected are given:

A. E. Mitchell, Lehigh Valley R. R.—Grades. Curvature. Condition of locomotive. Steaming qualities of locomotive. Quality of coal used. Quality of water used. Location of water stations, whether on up grades or levels. Speed required for fast freight. Speed required for slow freight. Proper distribution of time on time-table, so that faster time can be made on levels and descending grades and slower time on up grades. Condition of cars in each train, whether heavy on side bearings or otherwise. Size of journals under cars. Condition of journal lubrication. Weather conditions. Conditions of track and rail.

William Garstang, C. C. & St. L. Ry.:—Maximum boiler duty that can be depended on, with tonnage confined to a basis of equivalent steam consumption for various speeds. Scheduled speed between terminals. Actual speed necessary to make schedule time. Concentration of tonnage for reduction of flange resistance. Weather and temperature conditions.

T. W. Demarest, Penna. Lines West, N. W. System:—The character of the motive power. Transportation facilities as influenced by: (a) Physical character of the division, having reference to grades and alignment. (b) Whether it is a single-track railroad or a double-track railroad; passing siding facilities and terminal facilities. Density of traffic. Traffic requirements which cover the character of the business, *i.e.*, whether same is a low-class business on which a fast movement is not required, or whether it is a high-class business in which speed is one of the vital requirements. Each division of a system must receive individual analysis with above factors in view. The analysis for one division may or may not apply to the other divisions of a railroad; in general it will not. A further factor, of course, is such motive power facilities as will insure the prompt handling of the locomotives at terminals with a view of increasing the service hours for transportation purposes, and we, finally, have four conditions to be obtained: 1. Maximum service hours for the locomotive. 2. Maximum miles per hour for the locomotive considered as being available for transportation service for each hour of the entire month or year. 3. Maximum miles per hour for the locomotive while available for transportation purposes 4. Maximum tons per train for each individual train.

J. A. Carney, C. B. & O. Ry.:—The proper loading of a locomotive is the number of tons of train it can put in and get out of side tracks in a reasonable length of time and haul up maximum grades without doubling, either by running for the grade, if it is short and a stop is not necessary at the foot of the hill, or by a straight pull if the grade is long or a stop necessary at the bottom. The weight of the train should vary with the number of cars. Theoretical figures on tonnage rating per tractive force are not reliable, and while they furnish valuable data to base rates on, the local conditions may make them too low or too high. Actual service tests based on theoretical rating give the best results. On a level road the theoretical rating is generally too high and on a hilly road the theoretical rating may be too low where the maximum grade limits the tonnage rating.

W. R. McKeen, Jr., Union Pacific R. R.:—R. Resistance in pounds per ton of train. V. The miles per hour. T. The tons in train. L. The length of train. C. The number of cars in train, surface exposed to wind. The correction of temperature is an important one where the temperature varies from 20 degrees below zero to 105 degrees above zero. The correction for wind is an important one, particuarly in level country on the plains where the wind is almost constant and more important than the grade resistance. If curves are not compensated the same afford a factor for correction. The drawbar pull of the engine is dependent upon so many variable quantities and so many quantities upon which it is almost impossible to estimate that it would seem the engine capacity should be determined by means of a dynamometer car which would avoid any discussions as to the limit of same.

A. E. Manchester, C. M. & St. P. Ry.:—In my opinion no hard and fast rule can be laid down covering the proper loading of locomotives, except that all of the local conditions in connection with the service be taken into account.

J. F. Walsh, C. & O. Ry.:—Taking it for granted that a locomotive will not be started over a division unless in probably such condition as will enable it to make a successful round trip, I would say that weather conditions would be the only thing that should affect its hauling capacity; the latter can usually be approximately

determined by multiplying the tractive power by the number of thousands of pounds upon the drivers. This rule, we find, will give approximately what a locomotive can haul over a straight level track. In figuring on the resistance due to curvature, we figure that each degree of curvature is equal to a rise in grade of $1\frac{1}{2}$ ft. per mile. To determine approximately what an engine will haul up a given grade, we take $\frac{3}{8}$ of the number of feet rise in grade per mile, divide that sum into the tractive power, and that will give approximately what an engine will pull up a given grade. Our tonnage rating is determined by actual pulling tests.

H. L. Fowler, Consulting Engineer:—1. Train resistance. 2. Drawbar pull. The factors affecting the first head include the internal friction, air resistance, grades and number of axles in the train. The second varies with the tractive power of the engine and the condition of the rail. In order, then, to allow for the variations in these factors, I would suggest the lading should be so proportioned that, with the train resistance at a maximum, and the drawbar pull at a minimum, the engine should still be capable of taking its load over the ruling grades. That this may be done and still secure the maximum available load behind the tender, the weight of the trains should be adjusted on a sliding scale in such a way that the tonnage can be increased as the number of axles is decreased. In other words, so that the greater the capacity of the cars the greater the total tonnage.

J. H. Watters, Georgia R. R.:—The factor that affects mostly the economical loading of a locomotive is the one of overloading. A locomotive to do the best work and to show the most economical operation should be loaded with a train with which it can make schedule time over the heaviest part of the road.

C. H. Doebler, Wabash R. R.:—Weather conditions, rail conditions, the ruling grade, time required between terminals, number of trains to be handled over a given piece of track, distance between sidings and distance between coaling and water stations.

A. R. Kipp, Wisconsin Central Ry.:—The economical loading means the minimum cost to haul one ton one mile and is affected by: Wages, including those of enginemen, trainmen and roundhousemen. This item is more important on single-track roads than on double-track roads, as heavily loaded slow freights are more likely to affect other trains than those on double track. This item is controlled considerably by overtime. Fuel: There is an economical limit in the consumption of fuel beyond which the expense of operation rapidly increases. Locomotive repairs. Number of ton-miles hauled in a given period of time. This involves a question of investment in locomotives and car equipment and the amount of money earned with that equipment.

J. J. Conolly, D. S. S. & A. Ry.:—1st. Condition of locomotive. 2d. Quality of fuel used. 3d. Weather conditions.

E. B. Thompson, C. & N.-W. Ry.:—Moving as much freight as possible. Time. Length of division. Weather.

E. W. Pratt, C. & N.-W. Ry.:—Dynamometer tests. Condition of power. Time. Length of division. Condition of coal and water. Weather.

John Heath, C. & N.-W. Ry.:—The basis of rating should be the dynamometer car.

F. G. Benjamin, C. & N.-W. Ry.:—The fundamental principle of loading a locomotive should be based on the question of the most economical load that an engine can haul without the loss of wear and tear on the locomotive, the loss in consumption of fuel and the shortest time on the road. There is no question but what there is good economy in loading an engine to a point where there is a reasonable percentage of reserved power to enable it to handle a train over the heaviest grades and have a measure of reserve to take advantage of inclement weather and high winds; also to take advantage of the road.

T. J. Cutler, Northern Pacific Ry.:—1st. The weather condition. 2d. Speed over the division. 3d. Time on road in regard to overtime paid. 4th. The volume of business and the amount of power available. 5th. The length of passing tracks on the division.

Locomotive Driving and Truck Axles and Locomotive Forgings.

COMMITTEE.—F. H. Clark, J. E. Sague, S. M. Vauclain, L. R. Pomeroy, F. W. Lane, E. B. Thompson.

Your committee appointed in 1902 to draw up specifications for locomotive driving and truck axles and locomotive forgings, with instructions to defer our final report until after the Washington meeting of the International Railway Congress, has carefully considered the recommendations and discussion of our meetings of 1903 and 1904, and now presents the amended specifications given below for your consideration and approval. Your committee has conferred with representatives of the American Society of Mechanical Engineers and with members of Committee "A" of the American Society for Testing Materials, and a compromise specification suggested which we believe will be satisfactory to each organization, except as noted below for this Association. This compromise specification involves a change in the reduction of area from 35 per cent., as originally recommended by this committee, to 25 per cent. It also involves the bending test covered in our last report, specifying a 1 by ½ in. test piece bent cold, 180 deg., over a bar 1 in. in diameter. This test is recommended by both the American Society of Mechanical Engineers and the American Society for Testing Materials. Your committee, however, feels that it is not desirable, as it is hardly possible to get a 1 by ½ in. test piece without drilling a larger hole than we would care to recommend, and we believe further that the bending test is not essential, but that the information that would be derived from such a test would be more satisfactorily covered by the requirements for elongation and reduction of area. If, however, the members of the Association feel that the bending test should stand we will not object to having that test included in the specifications, but would suggest in that case the desirability of making the test piece ½ in. square, instead of 1 by ½ in. in section.

We wish to again call attention to the manner of taking the test piece by means of the tools described in our progress reports of 1903 and 1904, and especially to the drill submitted by Mr. J. F. Kincaid, of the American Locomotive Company, in the discussion of the report of 1904; also to the arguments in favor of the test piece taken by means of a hollow drill, which for convenience are restated below:

1. The physical test outlined is one which should insure proper hammer work.
2. It does not show the manufacturer which axle is to be selected for test.
3. The axle tested is not destroyed, but is available for use if it meets the requirements.
4. The test may be used in the purchase of small lots, most orders from railroad companies being for from six to ten axles.
5. The test does not require a discard and in no way adds to the cost of the axle.
6. It furnishes the manufacturer with a check of the work done in his plant.
7. The test is one largely used by the United States Government for forgings.

The members of your committee feel that these specifications shown below will insure good material, and recommend that the specifications be adopted and the committee discharged. [The recommendations will be printed in full in the proceedings of the Association.—EDITOR.]

Shrinkage Allowance for Tires.

Committee—F. J. Cole, J. E. Muhlfeld, A. S. Vogt, W. A. Nettleton.

The work assigned your committee was as follows: "To consider whether the present shrinkage allowance, 1-80 in. per foot, is sufficient for large-diameter wheels with cast steel centers."

We would recommend that the present shrinkage of 1-80 in. per foot in diameter be retained for all centers of cast iron and cast steel less than 66 ins. diameter, but 1-60 in. per foot in diameter be used for cast steel and cast iron centers 66 ins. and over in diameter.

From the replies received, correspondence and discussion among the members of the committee, the consensus of opinion is that the design of wheel centers, especially those of cast steel and of large diameter, has much to do with the question of loose tires. Your committee, therefore recommends that this question, including suggestions for preferred sections of spokes and rims, numbers of spokes, etc., would bear further investigation, which it might be desirable to refer to another committee.

That tires are rolled out or stretched when worn to, say, about $2\frac{1}{4}$ ins. in thickness has been confirmed by very careful measurements made of the tires after removal. The consensus of opinions and replies indicates that most of the difficulty experienced from loose tires occurs when they are worn to thicknesses varying from $1\frac{3}{8}$ ins. to $2\frac{1}{4}$ ins.

Loose tires are also caused by light cast steel centers of insufficient section of spokes and rims to resist the shrinkage of the tire. This may also be occasioned by the distance between hubs being too great, requiring the spokes to be dished. In such cases, when the tire is shrunk on, the wheel center will be dished. The suggested standard distance between hubs on locomotives for standard gauge is 55 ins. This allows the use of straight spokes.

Broken tires are often caused by bad shimming when tires become loose and shims and liners are used, which only partially cover the circumference of wheel center and do not butt against one another, but leave spaces several inches in length. The tire is unsupported at these points, and repeated transverse bending stresses are caused at each revolution of the wheel. Broken tires are again caused by too much shrinkage caused by improper gauging, and too much emphasis cannot be placed upon the necessity of providing a first-class system of gauges, both for boring tires and turning off wheel centers. These should be referred to master gauges from time to time, to insure their accuracy.

A very large number of passenger locomotives in use have driving-wheel centers 72 ins. in diameter. The Master Mechanics' standards are 70 ins., 74 ins., etc., and we would recommend including 72 ins. diameter among the number of standard sizes. The use of this size at the present time would warrant its recognition.

The Pennsylvania Railroad has used 1-64 of an inch per foot in diameter for a great many years for all sizes of wheel centers, both cast iron and steel.

The suggestions of the committee are summarized as follows:

Shrinkage 1-80th of an inch per foot in diameter for cast iron and cast steel centers less than 66 ins. in diameter.

Shrinkage of 1-60th of an inch per foot in diameter for centers 66 ins. and over in diameter.

Minimum thickness of tires should be established, due consideration being given to the diameter, service and weight per wheel.

Tire and wheel gauges should be of good design, heavy enough to resist bending and subject to frequent inspection to insure accuracy.

Seventy-two ins. diameter of wheel center should be included in standard sizes.

Wheel center rims should preferably be uncut, but, if cut, slots should be machined out and closed with solid cast iron liners driven in. No lead or white metal to be used.

Locomotive Tests of Pennsylvania Railroad at St. Louis Exposition.

COMMITTEE.—F. H. Clark, H. H. Vaughan, C. H. Quereau.

The members of your association, appointed in 1903, at the request of the Pennsylvania Railroad System, to serve on their advisory committee in connection with the locomotive tests to be undertaken at St. Louis, report that the tests of eight engines were completed, and that the data have been worked up and will soon be in the hands of the printers. It was found impossible to test the many engines as was intended, owing partly to delays in the arrival at St. Louis of a part of the testing plant equipment, and partly to unexpected difficulties in breaking in the plant.

We feel that the members of this association are more or less familiar with the work done on this plant and appreciate the

earnest and careful work done by the staff of the Pennsylvania Railroad engaged on these tests, but your committee wishes to record its appreciation of the energetic and thorough method in which the tests have been carried out, and to call attention to the immense amount of work involved in working up the data obtained.

It was not to be expected that in the limited time available it would be possible to settle all of the important problems of locomotive design in which we are so much interested, but we believe that a careful analysis of the final report will indicate that a great deal has been done in this direction, but that more perhaps has been accomplished in the direction of suggestions for future work and investigations. The report of the committee will probably be published in three or four months.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Brake Shoe Tests.

Committee—Charles Coller, William Garstang, W. F. M. Goss.

This report presented the results of tests on four brake shoes submitted to the committee and tested on the M. C. B. Association brake shoe testing machine at Purdue University. After recording results the report concludes as follows:

"As evidence of progress in brake shoe construction, your committee would call attention to the high frictional qualities of the shoes tested this year, as set forth in the preceding paragraphs, and to the fact that in improving their output manufacturers make frequent use of the association's machine. Work of this nature does not formally come to the attention of your committee. It is reported, also, that one manufactory is installing for itself a testing machine designed after that of the association."

Triple Valve Tests.

Committee—W. McIntosh, F. M. Scheffer, W. S. Morris, C. A. Schroyer, A. J. Cota.

It is probable that the coming year will require considerable work from the triple valve committee, as there are some remarkably interesting developments taking place in that line, and if the new devices some of us have had the opportunity of seeing perform on the testing rack prove as efficient in service, we may look for almost as much of a revolution in brake efficiency in the immediate future as there was when the automatic brake superseded the straight air brake. With this in view your committee would recommend the continuance of the triple valve committee, and that it be carefully selected to meet the prospective conditions; its members, so far as practicable, to be skilled in air brake matters, and instructed to confer with the Air Brake Association.

Draft Gear.

Committee—Le Grand Paris, E. D. Bronner, W. F. Kiesel, Jr., G. W. Smith, Mord Roberts.

The committee would recommend that the 1-in. total side clearance shown on M. C. B. Sheet "B" be increased to 2½ ins. total clearance. Would also recommend that experiments be made to determine how much more clearance can be safely used without the use of a centering device.

In view of the fact that the work of the draft gear committee is now so closely allied with that of the coupler committee, it does not seem that there is any use to continue the draft gear committee under present conditions. If it is not the desire of the association that the committee should take up the question of testing new designs, as was done several years ago, or improvement in old designs, it would probably be well to discharge this committee or merge it with the coupler committee.

Doors.

Committee—J. E. Keegan, W. E. Sharp, T. Treleaven, J. W. Muncy, D. Van Alstyne.

Your committee feels that the members are not particularly interested in the subject assigned, as shown by the very limited number of replies received and the meagre information brought out in answer to the circular of inquiry issued, and has no recommendations to make as to the revision of the drawings of outside door as shown in M. C. B. Sheet "F," or for suitable grain doors to meet the requirements of large capacity cars.

The American Association of Local Freight Agents, through its conference committee, submits a resolution adopted at the annual convention of that association at Peoria, Ill., in June, 1904, as follows:

"*Resolved*, That it is the sense of this association that better results would be secured if doors of 6 ft. in width be made the standard for all ordinary box cars, and that the matter be referred to the incoming conference committee with a view of obtaining such a standard through the Master Car Builders' Association."

The conference committee submits the question for consideration and action, believing that the adoption of standard width of 6 ft. for all ordinary box-car doors will promote the interests of trade and railway traffic in general.

Subjects.

Committee—J. S. Chambers, F. T. Hyndman, O. M. Stimpson.

SUBJECTS FOR COMMITTEE INVESTIGATION DURING THE YEAR 1905-1906.

1. A Standing Committee on Car Wheels. The Committee on Subjects deems this subject of sufficient importance for a committee to report from year to year on all subjects pertaining to design and specifications of cast iron wheels.
2. The use of metal in passenger equipment car construction. A committee to report on the advisability of the use of metal in passenger equipment car construction.
3. Brake Beams. A committee to prepare and submit specifications and tests for brake beams for 60,000, 80,000 and 100,000 lb. capacity cars.
4. Bolsters. A committee to prepare and submit specifications and tests for bolsters for 60,000, 80,000 and 100,000 lb. capacity cars.
5. The use of four-wheel versus six-wheel trucks for passenger service.
6. As to the efficiency of the different designs of side bearings.
7. Investigation of damage to cars, due to switching; including "Hump-yards."
8. The use of cast steel and wrought iron in car construction and their limits.
9. Pressed steel shapes in passenger car design.
10. The use of truss rods in passenger equipment cars.

Stenciling Cars.

Committee—H. M. Carson, J. S. Lentz, Jos. Buker, G. T. Anderson, W. F. Bentley.

Your committee has confined itself to the subject of stenciling freight cars, believing, if a general agreement can be reached upon this important subject at this time, that much good and economy will result. It will be noted that your committee has confined itself to the following recommendations:

First. The style of letters and figures to be used so that uniform stencils may be prepared and used on all freight cars.

Second. A uniform height of letters and figures for certain specified markings, so that in a general way these markings shall be uniform on all freight car equipment.

It will be particularly noted that the committee does not recommend the location on the car for the various markings, believing that each road desires more or less discretion in this respect, and also for the reason that this would be a very difficult matter at this time, on account of the various new types of steel car equipment being introduced, which will not permit the same location for similar markings as on the old wooden equipment they are superseding.

It will further be noted that the committee does not confine its recommendations for the height of letters to any one specified height, as a general thing, and in endeavoring to recommend certain limits for height for different markings, hopes that a general agreement within these limits may be arrived at. In recommending six sizes only for the heights of letters and figures, your committee believes that it has fairly covered the ground and given a choice which may be accepted by every one. Designs have been submitted for the type of Roman letter, which, it is trusted, will meet with general approval. The designs submitted are for the 7-in. letters and figures only. If these designs are accepted with the report by the convention, it is the purpose of the committee to prepare designs for the various other sizes of letters and figures recommended in the report and submit them for adoption as recommended practice by letter ballot.

First. It is recommended that the Roman letters and figures of the designs shown in the attached drawings be adopted for uniform stenciling of freight cars.

Second. It is recommended that the sizes of these letters and figures shall be confined to the following heights: 1 in., 2 ins., 3 ins., 4 ins., 7 ins. and 9 ins.

Third. It is recommended that 7-in. or 9-in. letters or figures be adopted for the initials or name and numbers for the sides of cars, and 4-in. letters or figures for the same markings on the doors and ends.

Fourth. It is recommended that for other car body markings on sides and ends, such as capacity, couplers, brake beams, class of car, date built, outside dimensions, inside dimensions and markings inside of car, 2-in. or 3-in. letters and figures be used, with the following exceptions:

1. All weight marks should be 3-in. or 4-in. letters or figures.
2. Trust marks, patent marks, and other private marks, should be 1-in. letters and figures.

Fifth. It is recommended that all marks on trucks should be confined to 1-in. and 2-in. letters or figures.

Sixth. It is recommended that stenciling on air brake cylinders or reservoirs should be 1-in. letters or figures.

It will be noted that the above recommendations of your committee conflict to a certain extent with the recommendations for stenciling certain markings on cars, adopted in 1896 and shown on page 451 of the 1904 Proceedings, in that certain letters containing fractional sizes are there recommended; and as it is a distinct recommendation of this committee that all fractional sizes shall be omitted, your committee would recommend that recommendations referred to be changed to conform to the committee's report. Furthermore, the design of stencil is shown in the report referred to for the A and B end of freight equipment cars, these letters being 1½ ins. in height and the circle 2¾ ins. in diameter. Your committee recommends that the relative proportion for these stencils be adhered to, but that the height of letter be increased to 2 ins., diameter of the circle being in proportion to the increase in size of letter.

In making its investigations your committee has found that very little uniformity exists in regard to the size and design of letters and figures of different sizes on any railroad, one shop a very short distance from another one on the same road often using stencils for the same letters and figures which materially differ from those used at the other point. It therefore seems extremely desirable at this time that some definite agreement be reached by this association, particularly in view of the proposed renumbering of freight car equipment on all railroads, and it is with the object of having some uniformity arrived at this year that your committee submits this report, which, while leaving some parts of this subject uncovered, particularly the location of the various markings, should at least be a long step in advance in obtaining uniform practice.

(*Additional reports will appear next month.*)

BOOKS.

Manual for Engineers. By Charles E. Ferris. Fifth edition. Published by the University of Tennessee, Knoxville. Price, 50c.

This small manual contains a number of valuable tables and other data, covering a wide range of engineering subjects, and while its real object is to increase the interest of men of affairs in technical training, it will be found very valuable for reference by engineers.

Boiler Room Chart, by George L. Fowler. Published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. This chart shows an isometric perspective, the interior of a modern boiler room, including all of the mechanism belonging to it. It shows water-tube boilers, automatic stokers, feed water heaters and pumps, piping and all of the features necessary to a boiler room, with a list of over 200 parts numbered and named. It is similar in plan to locomotive and car charts, with which the readers are familiar.

Automobile Pocket Book, by E. W. Roberts, author of the Gas Engine Hand Book; Pocket Size, illustrated, published by the Gas Engine Publishing Company, Goodall Building, Cincinnati, Ohio. 1905, price $1.50.

This little book is intended for the use of those who own or operate automobiles. It presents clear and concise information on the care of the machinery, devoting special attention to the engine. While it is elementary and is intended specially for those who know nothing about machinery, it contains information of special value for all who have to do with automobiles, whether they are familiar with machinery and gasoline engines, or not.

Plain and Spherical Trigonometry. By P. A. Lambert, assistant professor of mathematics, Lehigh University, and H. A. Foering, head master of the Bethlehem Preparatory School. The Macmillan Company, New York, 1905.

This book is evidently intended as a text-book. Its plan is to show the relationships between trigonometric functions in such a way as to develop the student's ability to think them out and apply them. The functions are defined by means of projections which have become familiar to the student through geometry. The book contains no tables of functions. The work will lead the student to reason rather than memorize. It contains many examples for practice.

PERMANENT WAY INSTITUTION; JOURNAL AND REPORT OF PROCEEDINGS. Published by the institution, 9 Grace Church street, London, E. C. Edited by Clement E. Stretton, Leicester, England. This pamphlet is to be issued monthly and devoted to the engineering department of railways, including all that appertains to way and works. The editor announces a number of papers on hand for publication, and the journal will be valuable in recording progress in the engineering work of British practice. This number contains papers on pile driving in connection with foundations, coal working under a railway, the training and position of the plate layer, and in addition a list of members and reports of council meetings.

High-Speed Tool Steels. By L. P. Breckenridge. Circular No. 1 of the University of Illinois Engineering Experiment Station.

This bulletin gives a brief account of the development of the high-speed tool steels, and announces a series of investigations which are to be made to determine the most economical speeds at various feeds and depths of cuts for different materials and different sizes of tools, and also to determine the effect of different angles of rake and clearance on the power required to drive the tool. For the present, tests will be made on various grades of cast iron. The circular contains several tables, giving the tabulated results of the most important experiments with these steels which have been made by various authorities. Copies of this circular may be obtained by addressing the Engineering Experiment Station, Urbana, Ill.

Electric Railways. Theoretically and Practically Treated. By Sydney W. Ashe and J. D. Keiley. 285 pages, 172 illustrations and 7 large plates. Published by D. Van Nostrand Company, 23 Murray street, New York. Price $2.50.

This volume treats of the rolling stock only and is intended for use in technical institutions and as a general engineering reference book for those interested in this subject. In addition to the consideration of the design and construction of the cars, there are chapters on the analysis of train performance, train recording and indicating instruments, electric locomotives and electrical measurements. This book is especially valuable because of the thorough treatment of the subject and the fact that the most recent developments are considered although it is to be regretted that more complete details of the electric locomotives could not be presented.

Cement and Concrete. By Louis Carlton Sabin, B. S., C. E. McGraw Publishing Company, 114 Liberty street, New York. Cloth, 507 pages. $5.00.

Though several comprehensive and valuable works upon reinforced concrete have recently appeared, Mr. Sabin's book is the first to come to our attention in which plain concrete is treated with equal fulness. In pursuance of the expressed purpose of its author to place in one volume a connected story of the properties and use of cement, Part I. is devoted to the classification and manufacture of cement, Part II. to the properties of cement and the methods of testing, Part III. to the preparation and properties of mortar and concrete, and Part IV. to the uses of mortar and concrete. Of these sections, Parts II. and III. are most timely, since Part I. is brief and conventional, and Part IV. consists in the main of a discussion of the uses of reinforced and plain concrete, a subject essential to the complete development of the scheme of the book and in itself excellently treated, but which can be found more fully discussed in other works. Among the features of the book which deserve special attention are the chapters upon the testing of cement, and the chapter upon the methods and cost of concrete making, both of which subjects are treated more completely and carefully than in any other work with which we are familiar. The results of a large number of interesting tests and studies are given, and these alone would make the book worthy of purchase by engineers and concrete makers, even were they unaccompanied by the valuable descriptive and explanatory text.

A Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson, with chapters by R. Feret, W. B. Fuller, and S. B. Newberry. John Wiley & Sons, 43 East 19th street, New York. Cloth, 588 pages. Price, $5.00.

This is the most scientific and exhaustive treatise upon concrete which has yet come to our knowledge, and great credit is due to Messrs. Taylor and Thompson for their careful and painstaking labor, evidence of which is displayed throughout the book. In addition to giving the results of their own extensive studies and research, the authors have greatly increased the value of the work by adding chapters from the pens of the well-known authorities mentioned above, and by obtaining their co-operation, as well as that of others, in the examination and criticism of all the important subjects presented. Besides providing for the needs of the student and the expert, the book is also admirably adapted to serve those who wish to find in brief and concise form directions for exact methods of procedure in making and laying concrete, special attention having been given to the needs of such readers. The book has too many valuable features to permit us to mention them all, hence we shall have to content ourselves with referring to only a few. Chapter I., entitled "Concrete Data," consists of a collection of facts in highly concentrated form, many of which have hitherto been obtainable only through a considerable study of numerous books and periodicals. Page references are given throughout this chapter, so that the reader may quickly find the discussion upon which any particular fact is based. The chapters dealing with the composition and testing of cement, including that by Mr. Newberry upon its chemical composition, are very thorough. Chapter XI., by Mr. Fuller, on "Proportioning Concrete," is notable for the new methods presented. If his conclusions are verified by the work of other engineers, they are likely to be of great value in rationalizing the method of proportioning. Mr. Feret gives in Chapter XVIII. the result of extended studies upon the action of sea water upon concrete. The theory and practice of reinforced concrete are treated at some length; simple formulæ are derived, and their application made easy by the insertion of tables of constants. The book is copiously illustrated, and the results of many hitherto unpublished experiments are included. It is our belief that this book will be for some years to come the most complete treatise upon concrete to be found in the English language. We advise all those interested in the subject to add it to their libraries and to study it carefully.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington, Civil Engineer. Published by Virgil H. Hewes, 245 West 107th street, New York City. Cloth, 991 pages, $5.00.

The greater portion of this bulky volume consists of a reprint in chronological order of Dr. Waddell's well known papers upon structural design, and the ensuing discussion in engineering pub-

lications. There are also included several articles upon railroad engineering, a number of essays upon engineering education, and various addresses delivered before the students of engineering colleges. A number of the papers included, notably "Some Disputed Points in Railroad Bridge Designing," "The Compromise Standard System of Live Loads," and "Elevated Railroads," were at the time of their publication productive of very thorough discussion by eminent engineers, hence a collection of these papers and discussions in one book presents, in a way, a history of recent development in this country of the design of framed structures. For this reason alone the book should be of value to younger engineers, and to engineering students, many of whom are not likely to ever acquire the publications in which the original articles appeared. To this same class of readers the addresses to engineering students will appeal strongly, as they are full of good advice upon practical questions from one well fitted to give such advice. The paper entitled "The Kansas City Flow-Line Bridge Repairs" is also particularly well adapted to such readers, as it presents fully the method of solving a serious problem in a limited time, a subject not treated in text books and seldom discussed in print. The articles upon engineering education are well worth serious attention by educators, though we are afraid that a general acceptance of some of the views therein presented is somewhat doubtful. The book is admirably edited, most of the papers being prefaced by editorial comment which is so well written and which shows so thorough a comprehension of the problems discussed as to form, in most cases, a valuable addition to the paper which it accompanies. These comments are also of value in putting the reader into the proper focus for studying some of the older papers.

The Uses of Hydraulic Cement. By Frank Harvey Eno.

This book is Bulletin No. 2 of Fourth Series of the Geological Survey of Ohio, and is published under the authority of the State. It opens with a statement that it "deals with the uses of hydraulic cement, a subject on which much accurate information is in existence, though not well distributed among those who have most need of it." Also, "while not the record of new and exhaustive researches" "to any important degree," "it has been the aim to present the facts," etc., in a "simple and clear manner," and it suggests that "in all the vast literature of the subject no other work yet accomplishes this simple purpose." This statement by the State geologist of the work of Professor Eno seems a fair presentation of the matter. The subject is treated in the following order: A brief history of cement; the uses of cement in mortars; the uses of cement in concrete; specifications for concrete materials; machinery and tools. The chapter on the uses of cements in mortars is taken up under headings, the most important being as follows: Development; advantages of cement in lime mortar; natural vs. Portland cement; effect of various sands on strength; effect of water on strength; permeability of cement mortar; effect of loamy sand upon mortar; colored mortars. Other headings of special interest are: Cement hardened quicksand; effect of freezing upon mortar; effect of heat upon mortar. The chapter on the uses of cement is also taken up quite fully, walls, abutments, culverts being among the headings, as also monolithic concrete houses, concrete block houses, sea walls, water pipes, tunnels, ties and rail beds, sidewalks, posts, telegraph poles. "The uses of cement in reinforced concrete" necessarily treats of things new, and needs to be up to date, and seems to be efficient in this particular. The description of various systems includes Monier, Roebling, expanded metal, Melan, Thacher, Hennebique, Ransome, Weber, Kahn, Columbian Cumming, De Man, and Luten. Concrete piles are touched upon, special note being taken of the Cushing, Raymond and Hennibique forms. Many pages are given to specifications for cement or concrete in various forms, and the final chapter takes up machinery and tools, crushers, screens, mixers and others. The book is profusely illustrated, and contains a number of tables. It neither does, nor pretends to do, much on the theoretical or mathematical side of the subject. It is a very creditable production. Nearly every engineer knows something of parts of what the book covers, but there are few who cannot find considerable that is new and well worth while among the many things contained in its 247 pages.

The Strategy of Great Railroads. By Frank H. Spearman. New York: Charles Scribner's Sons.

Usually the author of a book states its purpose in a preface. In the present instance there is no preface, so that the reader must infer its scope and objects from the contents. It consists of a series of articles in which are described the origin and originators, the locality occupied, the sources and character of the traffic, the managers, management, and operation of eleven of the great railroad systems of the country. These are the New York Central, Pennsylvania, Harriman and Hill Lines, Wabash System, Gould lines, Rock Island System, Atchison, Topeka & Santa Fe, Chicago, Milwaukee & St. Paul, Chicago & Northwestern, and the Chicago & Alton systems. Accompanying each of the articles is a map, showing the location of the main lines and all their ramifications. About twenty pages of large type are devoted to each, so the descriptive matter is necessarily brief and, happily, is concise. It may be said that any one wanting to get a general idea of the extent, location and traffic of the great railroad lines of the country can do so more quickly, and with the expenditure of less time and labor—and more agreeably, too—from this book than he probably could from any other source. Generally, what is said in it is laudatory and commendation of the lines, their officers and their management. There is little or no criticism of any of these, and the book reads as though the author wrote with free passes in his pocket. But it is impossible to go through the book without being interested in it, although there is a kind of hustling tone about some of the writing which, at times, rouses dissent and excites the reader to pencil interrogation marks on the margins. The execution of the maps, however, cannot be classed among its lesser deficiencies. In the production of some of them the main idea in the mind of the draughtsman must have been that the shortest distance between two points is a straight line, and all of them have the fault of the diagrams published in railroad guides and folders, in which the bases and perpendiculars of triangles have a propensity of assuming the position and dimensions of hypothenuses. A good set of maps, showing the real location of the different lines, would add immensely to the value of the book. On page 219 the weight of the consolidation engines on the Alton Railroad is given as 165 tons. What is probably meant is 165,000 pounds. But the book has the primary merit of being interesting, concise, and is well printed in large type, and in these days of much writing and printing, the reader will be grateful for these merits.

NEW CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Integrating Wattmeters.—Folder No. 4047 from the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., describes their new type B integrating wattmeter.

Lifting Magnets.—The Electric Controller & Supply Company of Cleveland, Ohio, are sending out a bulletin which describes their lifting magnets, and presents several interesting illustrations of work which may be handled to advantage with them.

Jeffrey Pulverizers.—Bulletin from the Jeffrey Manufacturing Company, Columbus, Ohio, emphasizing the important features of their swing hammer pulverizers, which have renewable breaker plates, screen bars and chilled linings.

Revolution in Boring.—The Davis Expansion Boring Tool Company, 202 Commercial Street, St. Louis, Mo., have published a small folder which describes and considers the advantages of their new boring bar, which is specially adapted for boring car wheels.

Electrical Apparatus.—The following bulletins have been received from the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.: No. 1,102, Westinghouse direct current multiple arc lamp for 110 and 220 volts; No. 1,104, portable instruments, and 1,113, belted type rotating field alternators.

Engines and Boilers.—The Atlas Engine Works, Indianapolis, Ind., have just sent out two very attractive catalogs, one describing their Atlas water tube boilers and the other their medium speed engines. The latter contains some very interesting information and data for engineers.

Columbia Sander.—We have received a handsome catalog from the American Wood Working Machinery Company, 136 Liberty street, New York, entitled "Success of the Columbia Sander," which describes in detail the essential features of this machine, and presents a number of strong testimonials from users. This sander is described on another page of this issue.

Friction Draft Gears.—The Gould Coupler Company, No. 1 W. 34th Street, New York, have issued a handsome catalog describing their new friction draft gears for passenger and freight cars and locomotives and also a friction buffer for passenger coaches, baggage and express cars. The construction of these gears is very simple and a number of tests are reported, which show that it has a high capacity with a small recoil action.

LIGHTING.—The Crocker-Wheeler Company published during the National Electric Light Association Convention at Denver a pamphlet, entitled "The Vital Subject Is Lighting." The cover illustrates a broncho-busting exhibition, which was given in honor of the delegates, while the pamphlet itself considers the equipment manufactured by this company for supplying lighting for anything from a yacht, or house, to the streets of a large city.

THREAD MILLING MACHINE.—We have just received from the Pratt & Whitney Company, 111 Broadway, New York, a unique souvenir mailing card. Moving a small catch allows part of the back to spring open, and displays a folder which illustrates several pieces of work done on a Pratt & Whitney thread milling machine, and emphasizes the great economies afforded by this machine on certain classes of work by giving the time which was required to finish the various pieces.

AN ELECTRIFIED RAILWAY SHOP DESCRIBED BY ITS MECHANICAL ENGINEER.—Bulletin No. 58 from the Crocker-Wheeler Company, Ampere, N. J., contains a reprint in abridged form of the series of fourteen articles on the application of individual motor drives to the old machine tools at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad, which appeared in this journal beginning April, 1903. This bulletin will be of value to those interested in the application of motor drives to either new or old machine tools.

ROLLER BEARINGS.—The Hyatt Roller Bearing Company, Harrison, N. J., has issued a very unique bulletin, entitled "With Good Ammunition and a Dead Sure Aim You Can Always Count on a Bag Full of Game." At the top of each page is a small engraving showing some scene in the progress of a hunt, and beneath this is an appropriate selection from the records of the sales department. The first page is entitled, "Good Ammunition," and shows two of the standard Hyatt shafting boxes, and under "Straight to the Heart" is a report of a comparative test between Hyatt roller bearings and ordinary babbitted bearings.

CONDENSERS.—The W. H. Blake Steam Pump Company of Hyde Park, Mass., have just printed an attractive catalog, No. 25, which describes the jet surface condensers manufactured by them. These range in size from the horizontal jet condenser of 800 lbs. capacity in steam condensed per hour, to 26,000 lbs.; while the twin simple and compound air pumps and jet condensers range in capacity from 38,700 lbs. of steam condensed per hour to 135,000 lbs. Measured by the same standard, the surface condensers with air and circulating pumps are built in sizes ranging from 4,100 to 40,000 lbs. capacity.

NOTES.

ARNOLD COMPANY.—This company has just commenced the installation of a complete light, heat, power and compressed air equipment at the new Missouri Pacific shops, at Sedalia, Mo., all material having been purchased.

DIAMOND CHAIN AND MANUFACTURING COMPANY.—Mr. W. P. Culver, formerly with the Cleveland Motor Car Company, has been appointed eastern representative of the Diamond Chain & Manufacturing Company of Indianapolis, Ind., with headquarters in New York.

KENNICOTT WATER SOFTENER COMPANY.—This company announces that the Booth Water Softener Company, 126 Liberty street, New York, has passed into their control and will represent them in the East.

WESTINGHOUSE FRICTION DRAFT GEAR.—The Westinghouse Air Brake Company has just received orders from the Baltimore & Ohio Railroad system for the equipment of 10,000 of their cars with Westinghouse friction draft gear. This will make a total of 25,000 cars on the system equipped with this device. It is interesting to note in this connection that the Pennsylvania system has now a total of 70,000 cars equipped with this draft gear. This indicates how favorably the managers of the large railroad systems look upon this apparatus for the dissipation of shocks in the handling of long trains composed of heavy cars. One of the features of the tests shown the visiting members of the International Railway Congress when they were at East Pittsburgh was the efficacy of this apparatus to save wear and tear on rolling stock.

A LONG STEEL COAL TRESTLE.—The Maryland Coal Company has ordered a steel frame coal trestle 272 ft. long and 25 ft. wide, with steel tipple house 99 ft. x 25 ft. for their mines at Wendel, Taylor county, W. Va. The contract has been placed with Wm. B. Scaife & Sons Company, Pittsburgh, Pa.

Mr. J. B. Hicks, representing C. A. Willoy and the David B. Crockett Company, distributed attractive souvenirs at the Manhattan Beach conventions. The knives presented by C. A. Willey are of excellent quality and are specially appreciated. The perpetual calendar with clock attached, presented by the David B. Crockett Company, was one of the most attractive souvenirs at the conventions.

AMERICAN STEEL FOUNDRIES.—This company announces the receipt of an order from the Atlantic Coast Line for 1,000 cast steel body bolsters for 30-ton box cars, to be built at the shops of the South Atlantic Car & Manufacturing Company, at Waycross, Ga.; and 2,000 cast steel body bolsters for the same class and capacity cars to be built by the Western Steel Car & Foundry Company, at their Anniston plant.

WESTINGHOUSE ELECTRIC AND MFG. COMPANY.—This company has just closed a contract for the equipment of the main generating station and four rotary converter substations of the Cincinnati Northern Traction Co. The power-house will be located at Hamilton, Ohio, and the original installation will be of 5,000 k.w capacity, with provisions for ultimately increasing it to 10,000 k.w. In the generating station will be located three 1,500 k.w. and one 500 k.w., 3-phase, rotating field, enclosed turbo-type generators, and three 300 k.w. rotary converters. Each generator will be driven by a Westinghouse-Parsons steam-turbine and excited by a direct-current generator attached to the end of the turbine shaft from which its power will be derived. Each substation will contain a 300 k.w. rotary converter supplied by three 33,000-375 volt step-down transformers. All transformers are of the oil insulated self-cooling type. Besides the above, the contract includes all necessary switchboards and protective devices for the control and protection of apparatus in the power-house and rotary stations.

EXCELLENT DINING CAR SERVICE.—No feature of traveling is more thoroughly appreciated than acceptable dining car service. A group of railroad men met in the dining car of the B. & O. 3 p. m. train from Washington to New York, reaching New York at 8 p. m. on time. They agreed that the dining car service was the best they had ever enjoyed, the menu being as follows:

Royal Blue Line, Dining Car Service, Dinner.—Astrachan caviar; onion soup, au gratin; strained chicken gumbo; radishes, cucumbers, salted almonds. Baked Delaware shad, Venitienne; sliced tomatoes. Soft-shell crabs, saute meuniere. Larded fillet of beef, au jus; roast spring lamb, mint jelly; mashed potatoes, new potatoes, rissole; string beans; asparagus, au Beurre. Roast Philadelphia squab, au Cresson. Claret wine punch. Heart lettuce, au Mayonnaise. Pistache ice-cream, macaroons, lemon meringue pie, strawberry short cake. Nabisco sugar wafers. California cherries. Roquefort and Neufchatel cheese, toasted crackers. Black coffee. Creme de menthe.

NEW ENGLAND SEACOAST.—This seacoast, the ideal recreation ground during the summer, is preparing to welcome her visitors. In a short while the beautiful North Shore of Massachusetts, including Manchester-by-the-Sea, Marblehead, Clifton, Rockport, Devereux, Gloucester, etc., will be festive resorts, assembling together the foreign embassadors and Washington diplomats who especially favor this section. Hampton and Rye beaches in New Hampshire, delightful pleasure resorts, in a few weeks will harbor thousands of amusement seekers; York, Kittery and Kennebunk are ready for the cottagers. Old Orchard will appear more smiling than ever this year. Portland fronting on Casco Bay and the delightful islands have donned their summer apparel. North of Portland the shore resorts to Bar Harbor and beyond in New Brunswick are ready for the summer influx. You can scarcely appreciate the beauties of the sea coast without a visit; but there are two publications which will do much to enlighten you. A beautiful portfolio containing twenty-eight half-tone reproductions of seashore views will be mailed by the General Passenger Department, Boston & Maine Railroad, Boston, upon receipt of six cents, and a descriptive booklet entitled, "All Along Shore," will be mailed upon receipt of two cents in stamps.

MANNING, MAXWELL & MOORE, INCORPORATED.—On May 31st a very strong corporation was formed under the laws of New Jersey, consisting of the well-known house of Manning, Maxwell & Moore and its allied manufacturing companies, the Shaw Electric Crane Company, the Ashcroft Manufacturing Company, the Consolidated Safety Valve Company, the Hayden & Derby Manufacturing Company, the Hancock Inspirator Company and the United Injector Company. The officers of the new concern are: Charles A. Moore, president; John N. Derby, vice-president; Martin Luscomb, vice-president; Stephen B. Aller, vice-president; Colby M. Chester, Jr., treasurer; J. H. Blue, assistant treasurer; Charles Arthur Moore, Jr., secretary, and Merle S. Clayton, assistant secretary.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. J. W. Duntley, president of this company, has returned from Europe with orders for 3,400 pneumatic tools, representing a value of more than $300,000. His trip was remarkably successful, and on the Continent it was found necessary to establish manufacturing facilities by the purchase of the factory and business of E. G. Eckstein, Berlin, Germany. Also that of the Lencke Company at St. Petersburg. This has become necessary because of the rapid introduction of pneumatic tools into shop, building and other large industries on the Continent. All foreign countries being well equipped with electricity, the electric drill seems destined to rival the air drill, and open up a new field for this company abroad. The English company has won its suits covering 52 claims concerning pneumatic hammers, thus placing this company in a specially strong position with reference to its patents. The plant at Fraserburgh, Scotland, is now in full operation. The month of May has brought the largest volume of business in the history of the Chicago Pneumatic Tool Company.

KENNICOTT WATER SOFTENER COMPANY.—This company has acquired several acres of land at Chicago Heights, Illinois, and is constructing a new plant, the present quarters at 35th and Butler Streets, Chicago, having proved entirely inadequate to the needs of its constantly growing business. The new plant will consist of a main building 80 ft. wide by 300 ft. long, together with an office building arranged for office, drafting room and laboratories, 40 ft. by 46 ft., two stories high. The other buildings will consist of a power house 40 ft. by 50 ft., and a machine shop 35 ft. by 80 ft. The buildings will be of brick, steel, and tile construction throughout. The main building is to be equipped with a traveling crane of 80 ft. span, the crane being arranged to cover the entire area of the building, the roof of which is in a single span. The yard space is to be covered with a traveling crane of 26 ft. span, erected upon steel posts. Provision is made for the entrance of cars into the main building, so that loading and unloading may be done under cover. All tools are to be equipped with individual motor drive. Large purchases of machinery have been made to supplement the equipment already in use.

BOSTON & MAINE RAILROAD.— The pamphlet entitled "Hunting and Fishing," issued by this road, would stir the blood of those who understand the woods and know the effect upon a busy life of a sojourn near to nature. This pamphlet describes the Rangeley lake country, the Dead River region; the upper Kennebec; Moosehead lake and vicinity; the Aroostook region; Washington County, Maine, the lakes of New Hampshire, the fishing of the White Mountain region; Pennigewassete, Conn., lakes; Lake Champlain; Canadian Provinces and Newfoundland. The pamphlet contains an excellent map of the New England fishing and hunting resorts, and the attractions of these regions are presented in such a way as to lead the hunter or fisherman to immediately look over his tackle and outfit for a dream of an outing, which must necessarily eventually lead to a visit to this country. Copies of this pamphlet and the fish and game laws, also other excellent literature may be had upon application to Mr. D. J. Flanders, general passenger and ticket agent, Boston & Maine Railroad, Boston, Mass. This department also announces the resumption of through train service for the season of 1905 on the Connecticut River line between New York, Portland, Poland Springs, Bar Harbor, the Maritime Provinces, White Mountain resorts, Montreal and Quebec.

CONVENTION EXHIBITS.

At the exposition in connection with the Manhattan Beach conventions of the Master Mechanics' and Master Car Builders' associations the following were among the exhibitors present:

Acme White Lead & Color Works, Detroit, Mich.
Adreon Company, St. Louis, Mo.
Ajax Metal Company, Philadelphia, Pa.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe and Foundry Company, Mahwah, N. J.
American Lock Nut Company, Boston, Mass.
American Nut & Bolt Fastener Company, Pittsburgh, Pa.
American Steam Gauge & Valve Manufacturing Company, Boston, Mass.
American Steel Foundries, New York.
Andrews, J. S. & Co., New York.
Anglo-American Varnish Company, Newark, N. J.
Baldwin Locomotive Works, Philadelphia, Pa.
Baltimore Railway Specialty Company, Baltimore, Md.
Besly, C. H., & Co., Chicago, Ill.
Bettendorf Axle Company, Davenport, Ia.
Bordo, L. J. Company, Philadelphia, Pa.
Bowser, S. F., & Co., Fort Wayne, Ind.
Bradford Draft Gear Company, Chicago, Ill.
Browning Engineering Company, Cleveland, O.
Buckeye Steel Castings Company, Columbus, O.
Buda Foundry & Manufacturing Company, Chicago, Ill.
Butler Drawbar Attachment Company, Cleveland, O.
Carey, Philip, Manufacturing Company, Lockland, Cincinnati, O.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
Cleveland Car Specialty Company, Cleveland, O.
Cleveland City Forge & Iron Company.
Commercial Acetylene Company, New York.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Company, New York.
Davis Expansion Boring Tool Company, St. Louis, Mo.
Dearborn Drug & Chemical Works, Chicago and New York.
Detroit Graphite Manufacturing Company, Detroit, Mich.
Detroit Lubricator Company, Detroit, Mich.
Diamond Machine Company, Providence, R. I.
Dickinson, Paul, Chicago, Ill.
Dixon Crucible Company, Jos., Jersey City, N. J.
Duner & Co., Chicago, Ill.
Edwards Company, The O. M., Syracuse, N. Y.
Electric Controller & Supply Company, Cleveland, O.
Electro-Dynamic Company, Bayonne, N. J.
Falls Hollow Staybolt Company, Cuyahoga Falls, O.
Farlow Draft Gear Company, Baltimore, Md.
Federal Company, Chicago, Ill.
Flannery Bolt Company, Pittsburgh, Pa.
Foster Engineering Company, Newark, N. J.
Franklin Manufacturing Company, Franklin, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Frost Railway Supply Company, Detroit, Mich.
General Electric Company, Schenectady, N. Y.
Gould Coupler Company, New York.
Hicks, J. D., representing C. A. Willey and the David B. Crockett Co.
Independent Pneumatic Tool Company, Chicago and New York.
Jenkins Bros., New York.
Kennicott Water Softener Company, Chicago.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Co., Chicago, Ill.
Nathan Manufacturing Company, New York.
National Malleable Castings Company, Cleveland, O.
New Jersey Tube Company, Newark, N. J.
Norton Grinding Company, Worcester, Mass.
Pittsburg Spring & Steel Company, Pittsburgh, Pa.
Safety Car Heating & Lighting Company, New York.
Saint Louis Car Company, Saint Louis, Mo.
Shelby Steel Tube Company, Pittsburgh, Pa.
Standard Car Truck Company, Chicago, Ill.
Standard Coupler Company, New York.
Standard Steel Works, Philadelphia, Pa.
Star Brass Manufacturing Company, Boston, Mass.
T. H. Symington Company, Calvert Building, Baltimore, Md.
Thompson, C. A., St. Louis, Mo.
Underwood, H. B. & Co., Philadelphia, Pa.
Walworth Manufacturing Company, Boston, Mass.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Westinghouse Air & Automatic Steam Coupler Company, St. Louis, Mo.
Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.
Wood, G. S., Chicago, Ill.
Woods Machine Company, S. A., Boston, Mass.
Yale & Towne Manufacturing Company, New York.

WANTED—Foreman for tool department of large engineering works. Must be first-class man. Apply stating experience and giving references, "C," AMERICAN ENGINEER AND RAILROAD JOURNAL, 140 Nassau street, New York.

WANTED—General storekeeper for large engineering works and foundry. Must be competent man. Apply stating experience, salary expected, and giving references, "C," AMERICAN ENGINEER AND RAILROAD JOURNAL, 140 Nassau street, New York.

WANTED—Position by a master mechanic with fifteen years' experience in charge of large shops. Would accept position as mechanical engineer or take charge of manufacturing plant. Boiler work and design a specialty. Would not object to travel. Address "A," care Editor AMERICAN ENGINEER.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

AUGUST, 1905.

CONTENTS.

STEEL FREIGHT CAR DESIGN.

BY C. A. SELEY.

In an address delivered before students and professors of Purdue University, Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, presented arguments worthy of the widest circulation. The very successful cars of his design now running on the Norfolk & Western, the Seaboard Air Line, the Louisville & Nashville and the "'Frisco System" support the views of Mr. Seley. These cars have all been illustrated in this journal. The portions of the address referring to steel frame cars are reproduced as follows:

Steel underframe cars do not employ truss rods as a rule. The sills are generally deep in section in the center, tapering to a lesser depth at the ends, the shape employed being generally called fish-bellied. This is not strictly correct, as the ideal shape should take into account the reaction of the load beyond the bolsters in determining the section at any point between the bolsters. This construction gives the greatest economy of material used in the sills, and while readily produced by the builders they are sometimes an embarrassment to the railroads, when it is necessary to repair them on account of a lack of facilities. They are either a pressed shape or a sheared plate, reinforced with angles at the edges. Very deep sills also interfere with free inspection under the car.

Suppose we undertake to make the entire framing of a box car of steel, working in the truss idea, not using truss rods nor girder side sills. We will use a steel channel for the lower chord or side sill and an angle for the upper chord or plate. For the verticals and diagonals, which in car building parlance are posts and braces, angles, channels, I beams and Z bars are applicable, as follows: Angles for corners, I beams for end intermediate posts, which are of special value for strengthening the ends of the car, the notoriously weak part of a wooden car. Channels for door posts and end plates and channels or Z bars for side posts and braces and end braces.

Investigation of a steel side framing for a car will surprise one, to find how light a section can be used for the vertical strength required. This is due to the great depth available for the truss. There is, however, another element to consider, which is not met with in bridge calculations. Cars have to be constructed to carry flowing loads, as of grain, coal, etc., and the sides have to stand a stress which has a bulging effect. A side framing, calculated only for the vertical load will not be strong enough, although it is by no means necessary to use sections heavy enough to withstand the calculated side thrust of the flowing load. The reason for this is an important one. It has been noted in the analysis of a wooden car framing that the tension members were relatively weak, being light rods. The wooden posts have to stand the side thrust strains. In a steel car frame as above described, the members being riveted top and bottom, the verticals are tension members in fact, and their own inherent strength against bulging is reinforced by their lading giving them a bowstring effect.

One railroad built a lot of box cars, using the lightest standard weight of 3-in. channel for the intermediate verticals and diagonals of the side framing. There was no question of the vertical strength, but the design had no precedent by which to judge of the effects of lateral thrust. These cars have been in service about four years, and numerous examinations have disclosed no signs of bulging, and as the road in question has recently added a large lot of these cars to their equipment, there was probably no mistake made in the original design in trusting to the light sections used.

Prior to making that design some interesting experiments were made with a wooden model, which consisted only of the side frames and floor, supported on the four points corresponding to the ends of the body bolsters. In the model, which was 1-12 size the sills, and plates were cut down so as to have almost no strength as beams. The verticals and diagonals were notched over the top and bottom members, the whole framing and floor weighing but 2¾ lbs. This was filled with cast iron washers, arranged symmetrically, corresponding to the lading the full length of a car, and when the experimenter got tired of putting in washers it was found that this frail construction was carrying 215 lbs. The deflection could be plainly seen and measured by suitable lines. The model was so well made that when the lading was removed it came back almost to the original lines. The load was replaced and then removed only from the ends beyond the bolsters, and the center deflection showed an increase by reason of the loss of the reaction of the end lading. The end loads were then replaced and then one-half of the load was removed, beginning at one end. This was to see the effect of maximum unsymmetrical lading in the center panel, which was opened as in a car door way, and not provided with the diagonal bracing used in bridge construction. The lines showed the S curve or shearing tendency very plainly, but the amount of the deflection and general behavior of the model while undergoing these and other unsymmetrical loading arrangements led to the belief that no special provisions for taking care of this shear need be made in the car framing. The center sills have to be beams or else be under trussed, their support being the bolsters, although, if necessary, the sides can be made to help them. The lower chord or side sill of the cars above mentioned was an 8-in. channel, that depth being employed for other reasons connected with the car construction, and not on account of the necessity for that depth of section as a truss member. The vertical stiffness of these sills and the center sills takes care of the shear due to any unsymmetrical lading ordinarily found in box cars.

This side truss construction is applicable to other types of cars, such as hopper bottom and flat bottom gondolas, used for transporting coal, ore, sand, etc. These types have a full unbroken side for the application of an uninterrupted truss. Provisions against bulging must be made by cross-tieing at the top or by special means at the bottom.

Over 10,000 cars have been constructed and are running, demonstrating the correctness of the principles involved in the side truss construction, and a considerable number are on order at various building shops.

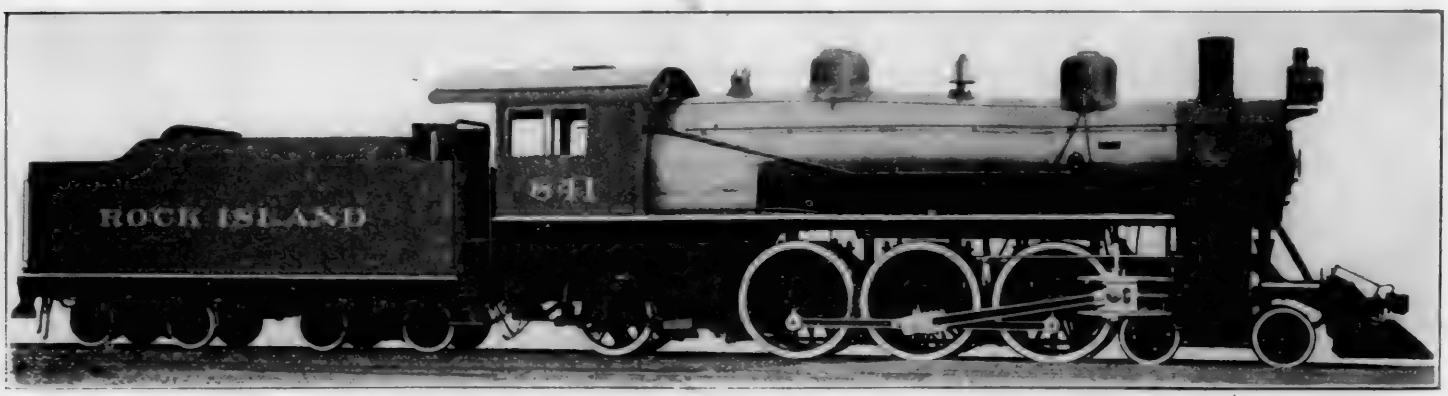
Particular attention has been paid in this paper to the steel frame box car, because it is regarded as the most important type on account of the number employed. It is desirable that a standard design of body should be made of the American Railway Association standard dimensions which could be used by all railroads, they to use their own particular designs of trucks. The importance of such standardization is obvious to all students of railway equipment maintenance. Whatever the arguments may be against steel, in the frames of all types of cars, the over-exaggerated fears of corrosion, difficulty of handling repairs with ordinary car labor, etc., the fact remains that on roads that have tried it steel has demonstrated its applicability and economy in maintenance, and in time will as generally supplant wood in car framing as it has already done in railway bridges. It will take a long time to do this, but the evolution is nevertheless quite sure, and I look for it largely on the lines of the simple, direct applications which I have indicated.

PACIFIC TYPE PASSENGER LOCOMOTIVE.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

The proposed standard locomotives recommended by the motive power committee of the Rock Island System were described in the March number of this journal, page 84, the five principal designs being illustrated by diagrams giving the leading dimensions. Several of these locomotives have already been built, the first chosen for illustration being the Pacific type passenger locomotive, as built by the American Locomotive Company at the Schenectady Works. Fifteen of these locomotives have now gone into service and are doing excellent work. By comparing the dimensions with those given in the tabular supplement accompanying the May number of this journal, of the current volume, it will be seen that this is not a remakably heavy locomotive. By comparing the dimensions with those of the fifth column of the proposed Rock Island standards in the March number it will be noted that comparatively few changes have been made from the details recommended by the committee.

This locomotive has a deep fire box, liberal heating surface, and is intended for service upon divisions with steep grades. The previous passenger locomotive of this type for this road built at the Brooks Works in 1903, was illustrated in this journal in October of that year, page 351. The present locomotive has 31,000 lbs. tractive power as compared with 28,600 lbs. for the earlier design. In the new standard Pacific type locomotive the firebox is 67 ins. in width, which is the adopted standard for the width of all the standard fireboxes. This locomotive has outside journals for the trailing wheels; it has supplemental frames under the firebox and differs in a number of its details from the earlier design. It has Richardson balanced slide valves and alligator crossheads. The following table presents the leading dimensions:



PACIFIC TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

T. S. LLOYD, *General Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*

Aside from the desirability of steel in car framing for the reasons stated heretofore, there is another important one. We need a very heavy backbone in cars with the present and increasing use of heavy engines. In the last ten years the average tractive power of locomotives has been greatly increased, and consequently the tonnage of trains is much greater. It has been found in these long trains that very severe shocks occur, back in the train, from the slack running up or out, as the case may be. The comparatively light draft gear of the old cars suffers much from these, as well as from the direct pull of the heavy engines now in use. The benefit of a direct steel column in the car framing to withstand these heavy pulling and buffing shocks is very evident. This consideration will justify the use of steel for even the medium capacity cars, as they are hauled in the same trains and by the same engines as the higher capacity cars. There is great mortality nowadays among the old light cars on railroads that use heavy power, and our repair tracks are full of bad order cars with the draft gear disabled, ends knocked out or pulled out. It is difficult in the very best practice in designing cars with wooden draft gear to provide a construction that will stand. This also shows the necessity for the stronger construction afforded by the use of steel.

I have seen an excellent man use a 6-in. instead of a 12-in. diameter emery wheel, and he thought he was saving $3.60 a month in supplies, but was really wasting $30 a month in wages.—*Mr. Harrington Emerson, Western Railway Club.*

PACIFIC TYPE PASSENGER LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive power	31,000 lbs.
Weight in working order	206,000 lbs.
Weight on drivers	133,800 lbs.
Weight of engine and tender in working order	351,000 lbs.
Wheel base, driving	12 ft. 4 ins.
Wheel base, total	32 ft.
Wheel base, engine and tender	61 ft.
RATIOS.	
Tractive weight ÷ tractive effort	4.31
Tractive effort x diam. drivers ÷ heating surface	638.
Heating surface ÷ grate area	74.8
Total weight ÷ tractive effort	6.64
CYLINDERS.	
Kind	Simple.
Diameter and stroke	22 by 26 ins.
Piston rod, diameter	3¾ ins.
VALVES.	
Kind	Richardson balanced.
Greatest travel	6 ins.

utside lap	1 in.
ead at ¼ stroke	¼ in.
WHEELS.	
riving, diameter over tires	69 ins.
riving, thickness of tires	3½ ins.
riving journals, main, diameter and length	9½ and 9 by 12 ins.
ngine truck wheels, diameter	33 ins.
ngine truck, journals	6 by 12 ins.
railing truck wheels, diameter	49 ins.
railing truck, journals	8 by 14 ins.
BOILER.	
tyle	Extended wagon top.
Vorking pressure	200 lbs.
utside diameter of first ring	68⅜ ins.
irebox, length and width	96 by 67 ins.
irebox plates, thickness	⅜ and 9-16 in.
irebox, water space	4½ ins.
ubes, number and outside diameter	328-2 in.
Tubes, gauge and length	No. 11, 18 ft. 7 ins. long.
Heating surface, tubes	3,175 sq. ft.
Heating surface, firebox	179 sq. ft.
Heating surface, total	3,354 sq. ft.
Grate area	44.8 sq. ft.
Exhaust pipe	Single.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 5¼ ins.
Center of boiler above rail	113½ ins.
TENDER.	
Tank	Water bottom.
Frame	13-in. channels.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,500 gals.
Coal capacity	13 tons.

A VERY FAST RUN.

When the distance from Chicago to Buffalo, over the Lake Shore & Michigan Southern Railway, was covered at an average speed of 65.07 m.p.h. on Thursday, October 24, 1895, a world's record was made for this distance. On June 12 and 13, 1905, a train of three private cars was run over the same road, a distance of 525 miles, at an average speed of 69.53 m.p.h., including stops and an average speed of 70.94 m.p.h. excluding stops. This was a special train composed of three officer's cars weighing 175 tons back of the tender. The accompanying table contains the official record of the speeds over each division, the figures having been taken from the train dispatchers' records. The locomotives of the 4600 class are 2—6—2 type, illustrated in this journal in 1901, page 69. Locomotive No. 5003 is of the 4—6—0 type, illustrated in 1899, page 343, and were the first locomotives of this type designed by Mr. W. H. Marshall when superintendent of motive power of this road. Locomotive No. 3707 is of the new class K, 2—6—2 type, illustrated in 1904, page 413, and is the heaviest passenger locomotive in the world at the present time. That this very heavy locomotive made such speed is worthy of special record. The figures presented include the length of each division, the time of departure and arrival, the time over each division, the distance and speed in miles per hour. All of the locomotives concerned in this remarkable run were built at the Brooks works of the American Locomotive Company.

That the record made last June did not involve any special preparation, whereas that of October 24, 1895, required extraordinary preparation, is a fact worthy of note. The record follows:

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Westbound, June 12, 1905. Private cars 201, 203, coach 340.

	Time over division.	Distance.	Average speed per hour.
Engine 4692.			
Lv. Buffalo.... 5:15 a.m.			
Av. Cleveland. 7:50 a.m.	*2 hr. 35 min.	183 miles.	*70.8 miles.
Engine 4665.			
Lv. Cleveland.. 8:00 a.m.			
Av. Toledo.... 9:33 a.m.	1 hr. 33 min.	108 miles.	69.66 miles.
Engine 5003.			
Lv. Toledo.... 9:36 a.m.			
Av. Elkhart...11:30 a.m.	1 hr. 54 min.	133 miles.	70.00 miles.
Engine 695.			
Lv. Elkhart... 11:33 a.m.			
Av. Chicago... 1:05 a.m.	1 hr. 32 min.	101 miles.	65.86 miles.

*Including a 2-minute stop at Erie.

Average speed, 525 miles, including stops, 67.02 m.p.h.

Average speed, 525 miles, excluding stops, 69.69 m.p.h.

Eastbound, June 13, 1905. Private cars 201, 203, coach 340.

Engine 695.			
Lv. Chicago... 6:30 a.m.			
Av. Elkhart... 8:22 a.m.	1 hr. 32 min.	101 miles.	65.86 miles.
Engine 4661.			
Lv. Elkhart... 8:24 a.m.			
Av. Toledo....10:18 a.m.	1 hr. 54 min.	133 miles.	70.00 miles.
Engine 4665.			
Lv. Toledo....10:20 a.m.			
Av. Cleveland 11:51 a.m.	1 hr. 31 min.	108 miles.	71.20 miles.
Engine 3707—685.			
Lv. Cleveland..11:55 a.m.			
Av. Buffalo... 2:25 p.m.	*2 hr. 30 min.	183 miles.	*73.20 miles.

*Including a 3-minute stop one mile east of Dunkirk.

Average speed, 525 miles, including stops, 69.53 m.p.h.

Average speed, 525 miles, excluding stops, 70.94 m.p.h.

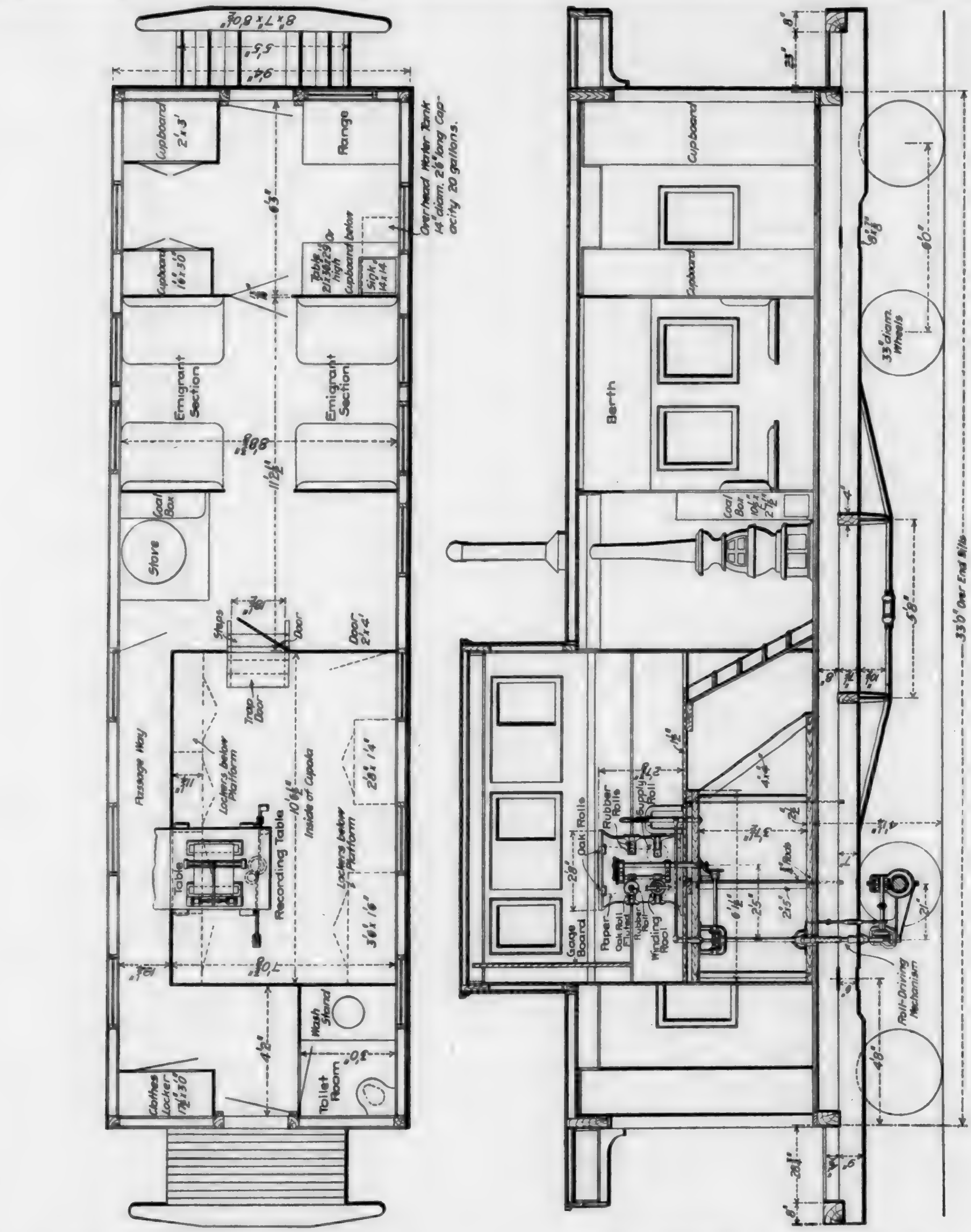
STEEL FOR PASSENGER CARS.

Every railroad wreck that has as one of its horrors the burning to death of imprisoned passengers calls attention afresh to the steel car and the larger place it must take in the construction of passenger as well as freight cars. The resistance of steel to the terrific impact of the derailed train at Mentor, Ohio, recently might have saved a number of lives. Certainly with steel cars there would have been no kindling pile and no charred bodies. The purchase of steel cars for the New York Subway was prompted chiefly by the desire to make the best provision against fire, derailment and collision. The latest of the tube railways in London is equipped with steel cars for the same reason. It would seem that the large death lists from fires on steamers, in public halls, hotel buildings and railroad wrecks in the United States in the past 18 months have given sufficiently terrible emphasis to the need of a larger use of non-combustible materials for buildings, cars and vessels.

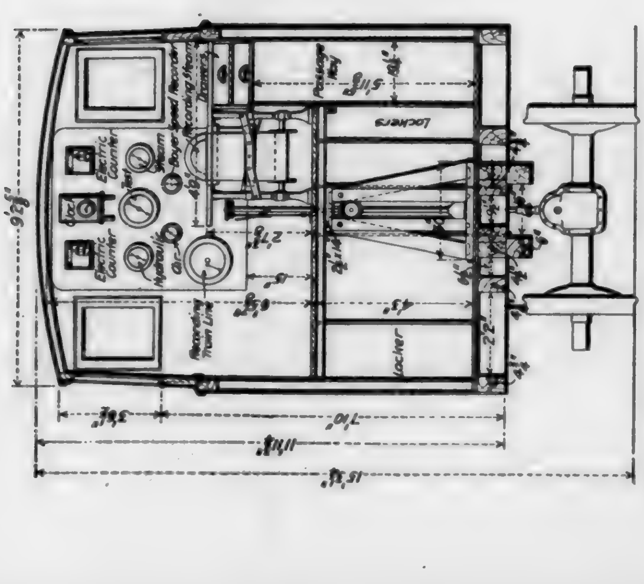
Steel as a material of construction has made its way because of its strength, its resistance to the elements, or because of its economy of space, or for other reasons appealing to the engineer. It is evident, in the apparently increasing dangers of crowded modern life, that steel will come into increasing use because it affords greater security to human life. In the past 20 years the metallurgical engineer and the mechanical engineer have worked together to cheapen it so that the civil engineer could employ it more freely. It is safe to predict that a large factor in the steel tonnage of the future will arise from uses which are optional to-day, but which public sentiment will then make compulsory.—*Iron Age.*

Cranes for Coaling Locomotives.—Our experience with the self-propelling 3,000-lb. crane at places where we do not have room or the means for installing a modern coal plant has reduced the cost of our coal, and our loading expenses, from 13 to 6 men, by the installation of a central self-propelling crane. It will clean out a gondola car, with the exception of the corners, and 15 minutes' work on the part of a man with a shovel will get the coal out of the corners. It will also take the ashes out of a level track or pit, and it is quite handy in every way. I mention these things with the hope that some of our members may profit by the suggestion.—*Mr. J. F. Walsh, before Master Mechanics' Association.*

Detroit Tunnel.—The construction and the electrification of the Detroit Tunnel Line from Windsor, Ontario, to West Detroit Yards, Mich., for the Michigan Central Railroad, has been placed in charge of an advisory board of engineers, consisting of Mr. William J. Wilgus, vice-president of the N. Y. C. & H. R. R. R.; Mr. Howard Carson, consulting engineer, and Mr. W. S. Kinnear, chief engineer of the Tunnel Company. The chief engineer will be in direct charge of construction, reporting to Mr. H. B. Ledyard, chairman of the board of directors, on executive and financial matters, and to the board of advisory engineers as to plans, specifications and methods of doing the work.



PLAN AND LONGITUDINAL SECTION THROUGH DYNAMOMETER CAR, SHOWING ARRANGEMENT OF APPARATUS—NORTHERN PACIFIC RAILWAY.



CROSS SECTION THROUGH DYNAMOMETER CAR.

DYNAMOMETER CAR, NORTHERN PACIFIC RAILWAY.

The new dynamometer car built by the Northern Pacific Railway combines features which have been employed in other cars previously put into service. It employs the raised location of the operating table which was used in the New York Central dynamometer car which was illustrated in the June number of this journal, page 198. The operator's platform in the Northern Pacific car is 10 ft. 6 ins. x 7 ft., with a passageway on one side of the car. The platform is raised about 4 ft. above the floor of the car and the cupola gives the observers a clear view in both directions, provided the cupola is not enveloped in smoke from the locomotive.

For transmitting and measuring the drawbar pulling and buffing stresses, hydraulic apparatus is used, this being similar to the equipment of the dynamometer cars of the Burlington and of the University of Illinois. The drawbar stresses are received

an oil cylinder communicating by piping to the recording table. These pipes lead to a pair of small cylinders, in tandem, having a piston rod in common. The movement of this rod is opposed in each direction by a carefully calibrated spring, the loads for small increments of deflection being known. The pen arm records the deflections of these springs under the pressure from the cylinder operated by the drawbar. The engraving clearly illustrates the paper driving mechanism and the location of the gauge board.

This car was originally a caboose, 33 ft. long, strengthened and practically rebuilt. The plan shows the arrangement of the interior and the facilities provided which are adapted to comfortable living for the attendants during relatively long periods.

APPRENTICE SYSTEM.—GRAND TRUNK RAILWAY.

Mr. W. D. Robb, superintendent of motive power of the Grand Trunk Railway, described the apprentice system of that road before the Master Mechanics' Association as follows:

I have realized for some time that the teaching of our employees, and especially our apprentices, for positions of responsibility in the motive power department, was a question which could not be neglected, and the system which we have, while it has been in force on the Grand Trunk for a number of years—I went through it when I served my time—latterly it dropped away; but I found that there was a shortage of material, that we ran out of men, and I had difficulty in obtaining men for positions of responsibility, difficulty even in obtaining men for good positions as workmen, and I decided that it would be necessary to educate our own men. I therefore introduced the apprentice system, starting in with indenture papers. Every boy is indentured. He signs himself and is signed by his parent or guardian, and these indenture papers prevent them from joining any union as long as they are serving their apprenticeship. We had difficulty in obtaining apprentices when we started, a great deal of difficulty; but after the system became known and the parents realized the benefits which the boys would receive, that difficulty disappeared. For your information I will just tell you the number of apprentices we have. At Montreal we have 234 machinists, 90 apprentices, a percentage of 38; at Toronto 64 machinists, 25 apprentices, a percentage of 39; at Stratford 289 machinists, 110 apprentices, a percentage of 38; at Fort Gratiot 110 machinists, 60 apprentices, a percentage of 54. We have an average of 40 per cent. of apprentices.

At first the system was voluntary—that is, the drawing and the teaching of apprentices; but I found that would not do, and it was made compulsory. An apprentice boy is given to understand when he comes in that he has to pass an examination. Unless he passes that examination successfully he cannot enter the service. The schools start in October and they end in April. The list of apprentices is given to the teachers. The teachers are provided by the company, as are the room, the light and the heat, and all that the apprentice has to do is to buy his own instruments. The list of names is given to the teacher of every apprentice in the works, and the roll is called. Every boy who is absent has his name sent to the master mechanic the next day as a warning, and he has to give a reason for his absence. If his reason is good it is accepted; if not, he is censured. If he does not attend he is discharged. The boy has to pass an examination before he receives his increase. All the increases received are on his indenture papers. We deduct from his daily rate and keep so much—a percentage—until he is out of his time. When he is out of his time that money is paid to him, and along with it a bonus. We have found that by having that system of indenture and holding the money back we are able to hold our apprentices, which we formerly were not able to do. These boys have to pass an examination before they receive their increase. The examination takes place before the shop expert, and it includes drawing and all the subjects of the system of examination. It is a written examination, and it all comes up before the master mechanic, receives his approval, and then comes to me. If his examination is not satisfactory he is sent back for six months and receives no increase. If he fails on his second examination he is discharged. In addition to teaching drawing we are now teaching them theory, applied mechanics and mathematics. We have no difficulty, as I said before, in getting apprentices for machinists, but we did have difficulty in getting apprentices for boiler makers, blacksmiths and rivet boys and steam hammer boys, and it was necessary to take on younger boys and boys who did not have sufficient education to pass the apprenticeship system. We have now introduced a school along with the drawing and the other training to teach these boys, writing, arithmetic, reading and spelling, and they come in younger than the other apprentices. They have to pass examinations on that as well as on the other, and after they pass that examination they are brought forward as machinist apprentices. In the spring of the year, at local points, prizes are given for the best standing. That is, locally. In addition to that prizes are given for the whole system, for which the boys compete over the entire system. Now, I want to say that I can assure this association that we find a very great deal of benefit from the system which we have. In fact, we have reached the point now where we are able to get sufficient material for promotion on our own system without having to go outside for it.

AN ECHO OF THE INTERNATIONAL RAILWAY CONGRESS.

Referring to the recent Washington meeting of the International Railway Congress, this journal in its June number said: "The value of the official discussions would have been much greater if those other than delegates were permitted to know exactly what was said in the meetings. The reports of the discussions, after the censors had finished with them, were robbed of much of their value and it is to be hoped that at some future time the star chamber character of the discussions may give place to a more modern and enlightened plan, as there can be no satisfactory reason at this day and date for discussing technical railroad subjects behind closed doors." A similar criticism from a correspondent of the London *Times* was expressed in that publication as follows: "The official reports, as published from day to day in the journals of the Congress, were ridiculously inadequate, especially for the important technical journals of Europe and America, and the exclusion from the meetings of the contributors on engineering subjects to those publications seems, from both a British and American point of view, to have been the greatest possible mistake. By excluding the technical press the Congress lost an opportunity to make its work known, which nearly all of the British and American delegates who have been consulted on the subject have regretted. If the International Railway Congress is to fill its proper place in connection with the advancement of transportation interests this secretive policy must give place to one consistent with the dignity and the aims of this organization. The organizations which occupy the highest posts are those the discussions of which are cast widely before the world, while fresh, by the technical press, and in this country, at least, the press has exerted a powerful influence in improving the work of technical organizations by suggestions of the technical press itself."

One lesson of the Washington convention is the desirability of removing this obstruction. Another lesson is the impossibility of delegates, representing railroad interests in various countries of the world, ever getting together in agreement upon the conclusions in matters of practice without robbing those conclusions of all value and even all interest. What the International Railway Congress should do is to open its meetings, improve its discussions, place those discussions widely before the world and allow those who wish enlightenment from this source to secure it and adapt it to their own needs. That which delegates of 46 countries, all over the

globe, can agree upon as "conclusions" is the least important element to be gained from such studies as this organization is able to make. Great good is accomplished by the International Railway Congress, but those who are directing its career should be brought to think of its loss of influence due to these causes.

SERVICE AND SAFETY OF M. C. B. CAST IRON WHEELS.

In a discussion of the question, "How does the M. C. B. cast iron wheel show up in service as regards flange breakages?" Messrs. R. L. Ettinger and G. L. Fowler offered the following before the Master Car Builders' Association:

Mr. Ettinger.—The 1904 cast iron wheel has not been in service long enough to state that the design is perfect and will remedy all defects in former patterns, nor was it claimed by the committee presenting it that they believed it to be the only design that would give good, satisfactory service; but the 1904 wheel was presented as the best they had to offer by a very representative committee of this association, ably assisted by a committee representing a majority of the largest wheel makers in the United States. These manufacturers must be satisfied that they are on the right track, as I have recently heard from a number who are now prepared to furnish this design, one writing that the 700-lb. pattern was made shortly after the convention last year and a great many thousand wheels from it put under cars of 100,000 lbs. capacity from which they have had practically no complaint.

The company with which I am connected put 8,000 wheels from this design in service last winter under 100,000-lb. steel coal cars. These cars are operating on some very heavy grades, and up to the present time we have not had any failures. Of the lighter wheels for 60,000-lb. cars we have a larger number running.

On a road in the west they had a number of very high coal cars that were giving a lot of trouble from breaking wheels, and it was decided to try the new M. C. B. design. The wheels were changed under some 200 cars, and I am told that none of the new wheels have failed. In this same connection and leading up to the change there were some tests made at Purdue University of types of wheels in general service and wheels made from the new M. C. B. pattern. All of the results were in favor of the new design.

The breaking of flanges will be reduced to a minimum for cast iron wheels by the addition of ⅛ in. more metal on the outside. This increase will amount to but little more than 1-16 in. on a line with the wheel tread, and this will not affect guard rails set at 1¾ in. any more than a driving wheel having the common distance of 53¼ in. between flanges, or a car wheel and rail that have a combined wear of 1-16 in. The co-operation of our road departments could very rapidly bring about the same relative conditions that now exist.

On going into this question very carefully with our engineering department we could not find any objection from their point of view to making the change in the wheel and using them on the tracks as now laid, or on their part to increasing the clearance between main and guard rails to 1⅞ in. on all new or repair work, and this has been decided upon.

We took this matter up with our engineering department with some hesitancy, because there had been so much said about the objections we might expect to meet with, but in place of objections found a perfect willingness and desire in that department to do anything the mechanical department asked with the view of better wheel service and fewer failures.

Mr. Geo. L. Fowler.—I have not had the privilege of having had charge of any cars of 100,000 lbs. capacity using cast iron wheels, but I have been commissioned on two or three occasions to look into the service of cast iron wheels under various conditions. The position, it seems to me, as it stands to-day, is that there is an uncertainty in regard to the advisability and the safety of using a cast iron wheel under a car of 100,000 lbs. capacity. Under a 60,000-lb. capacity car there is no doubt whatever but that it is all right. Under an 80,000-lb. car they seem to think that it is just about on the verge of the upper limit. With regard to the 100,000-lb., the general sentiment, as I find it through the community, is one of doubt. To remedy these defects, changes have been made in brackets, in the location of the plates and the thickness of the metal, in order to strengthen the wheel, and these have been to a certain extent successful, but there have been a number of cracks, and some very peculiar cracks developed in action on mountain roads. It has been found that the brake action in heating the wheel is apt to produce an internal crack that no inspector can see, and it works its way to the outside, breaking in detail, as though there were an inherent defect in the wheel as it came from the foundry, while it is really due to the brake action, because the same thing has been reproduced by subjecting a wheel to a thermal test; not the thermal test with a thick band of metal, but with a thermal test of about ¼ in. molten iron, heating it about as the brake shoes would heat, and reproducing an internal crack which cannot be seen by any kind of an inspection.

Now, with regard to the strength of the cast iron wheels: Professor Goss, at Purdue, recently took some cast iron wheels and put them in his testing machine, laid them flat and forced a square pressure bar down against the flange, holding it in place so that it could not back off, with some rollers to overcome the frictional resistance between the bar and a supporting angle back of it; and with this he pushed the flange down off the wheel. He told me the other day that a normal wheel broke at 70,000 lbs. pressure. I heard of this a few weeks ago, and thought I would like to corroborate those figures for myself and try to ascertain the relative strength of a steel-tired wheel or a steel wheel. I wrote to Prof. Goss, asking him if he thought that he could do the work on his testing machine, and calculated that it ought to take about four times or four and a half times as much pressure to push off the steel flange as a cast iron flange. I based my calculation on the comparative tensile strength of the metals, which for cast iron wheels runs from 28,000 to 30,000 lbs. and for the steel tire runs from 112,000 to 125,000 lbs. I made some tests a short time ago of the tensile strength of steel tires and found that they broke at from 112,000 to 113,000 lbs. per sq. in. Similar specimens from the tread of the Schoen steel wheel broke at stresses ranging from 118,000 to 123,000 lbs. per sq. in.; so that there is not much difference between the two.

Professor Goss said he was unable to do the work in his machine, so I requested the Schoen Steel Wheel Company to lend me their press, which has 1,000 tons capacity; I procured a cast iron wheel that the makers knew I was going to use for that purpose, and they sent me one that was a little thicker on the flange than the law really allows, with a chill that measured about ⅛ in. in the throat, so that there was a backing of good solid gray iron in behind there to stand the stress. My figures on that are not, of course, absolutely accurate, because I was working on a large press where I had to allow for the weight of the head and also for the frictional resistance of the packing, but as the frictional resistance of the packing has been pretty thoroughly worked out, there is probably not much error in my figures. The method used was to bolt the wheel firmly to the base of the press and to force a plunger bar down against the flange. The bar was prevented from backing away by a stiff angle bolted to the bed, the rubbing surfaces between the two having been well greased. This is essentially the same method as that used by Prof. Goss. I broke the flange of that chilled iron wheel at a pressure of 116,000 lbs., and it fractured silently with no apparent recoil. The flange of the Schoen steel wheel broke at 526,000 lbs., showing that there is not very much difference in the relative value of the strength of the flanges and the tensile strength of the metal that was in the wheels. In the case of the cast iron wheel under consideration, I did not measure the tensile strength. At the present time I am engaged in an investigation to ascertain what the vertical stresses are on a wheel, and I would suggest that we are very much in the con-

ition of a man who would attempt to build a bridge without nowing anything about the load that that bridge was going carry. You are running your wheels at all kinds of velocities, with all kinds of loads, over all kinds of tracks, and there no one that knows anything at all about what the actual ange stresses are. If the flange of a cast iron wheel is only orth 70,000 lbs., which Professor Goss tells me is the normal ress, it looks to me as though we were running very near e danger line when we are putting it under cars of 100,000 s. capacity, high, as these cars are when loaded away up igher than the old box car used to be, hauling them over all grees of curvature and all kinds of track, without knowing anything at all about the stresses to which we are subjecting them. I would suggest that it would be a very appropriate thing for this association or some railroad or combination of railroads to investigate what the horizontal tresses are on a wheel when it is in motion. The matter would not be a very serious one either in time or expense and would certainly serve to cast light upon a subject which, at the present time, is shrouded in darkness.

MALLEABLE IRON FOR WEARING SURFACES.

The use of malleable iron for wearing surfaces has been somewhat limited, but a general answer to the question, "is it advisable to use malleable iron for wearing surfaces," would be, No. Owing to the softness of the metal, the abrasion is very marked and harder iron has longer life. This can readily be seen in passenger car journal boxes where after a few months' service holes are worn through the sides of the boxes, and such surfaces are now protected by steel wearing strips. For parts subjected to a lesser degree of motion, such as center plates, side bearings or draft gear, the malleable iron will prove satisfactory if properly designed, care being taken to so proportion the wearing surfaces as to keep the load per unit of surface and the friction within safe limits. While malleable iron may furnish a fairly satisfactory wearing surface under favorable conditions, the general tendency is to restrict its use to purposes for which, as a substitute for cast-iron, its greater strength makes it particularly valuable.—*T. A. Foque, topical discussion before M. C. B. Association.*

Automatic Machinery for Railroad Shops.—The question of automatic machinery is one that should receive a great deal of thought. Duplicate work can be turned out economically by its use, and a railroad company can save considerable money by standardizing studs, bolts, pins and a hundred other things, making them at the principal shop with automatic machinery and distributing them over the whole road.—*Mr. H. T. Bentley, Western Railway Club.*

Rail Failures.—The results of our investigations indicate that the greater part of the difficulty which occurs to-day with rails under heavy traffic is due to unsound condition of the steel, a condition which existed in comparatively slight degree in the earlier rails.—*Robert Job, American Society for Testing Materials.*

COLE BALANCED COMPOUND.

Erie Railroad.

The excellent results obtained from the Cole balanced compound on the Pennsylvania Railroad testing plant at the St. Louis Exposition and its successful service on the New York Central justify expectations of equally satisfactory results under the difficult conditions on the Erie Railroad which have been outlined in this journal. The accompanying engraving illustrates a 4—4—2 type locomotive built by the American Locomotive Company, at Schenectady, upon the Cole balanced compound system. Comparisons with the earlier Cole compound may be made by referring to our June number, 1904. The leading dimensions of the Erie locomotive are given in the following table:

COLE BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD.

G. W. Wildin, *Mechanical Superintendent.* American Locomotive Company, *Builders.*

ATLANTIC TYPE COLE BALANCED COMPOUND LOCOMOTIVE—ERIE RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	23,860 lbs.
Weight in working order	206,000 lbs.
Weight on drivers	115,000 lbs.
Weight of engine and tender in working order	368,800 lbs.
Wheel base, driving	7 ft.
Wheel base, total	28 ft. 9 ins.
Wheel base, engine and tender	60 ft. 9 ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.82
Tractive effort x diam. drivers ÷ heating surface	513
Heating surface ÷ grate area	64.3
Total weight ÷ tractive effort	8.63
CYLINDERS.	
Kind	Compound.
Diameter and stroke	15½ and 26 by 26 ins.
Piston rod, diameter	3 ins.
VALVES.	
Kind	14-in. Piston.
Greatest travel	6 ins.
Steam lap	1 in.
Setting, ¼ in. lead forward motion when cutting off at 11 ins. of the stroke.	
WHEELS.	
Driving, diameter over tires	78 ins.
Driving, thickness of tires	3 ins.
Driving journals, diameter and length	10 by 12 ins.
Engine truck wheels, diameter	36 ins.
Engine truck, journals	6½ by 12 ins.
Trailing truck wheels, diameter	50 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Extended wagon top.
Working pressure	220 lbs.
Outside diameter of first ring	70¾ ins.
Firebox, length and width	108 1-16 by 75¼ ins.
Firebox plates, thickness	⅜ and 9-16 ins.
Firebox, water space	front, 4 ins; sides and back, 3½ ins.
Tubes, number and outside diameter	388 2-in.
Tubes, gauge and length	11, 17 ft. long.
Heating surface, tubes	3,433.55 sq. ft.
Heating surface, firebox	188.47 sq. ft.
Heating surface, total	3,622.02 sq. ft.
Grate area	56.3 sq. ft.
Exhaust pipe	Single
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 2¼ ins.
Centre of boiler above rail	111⅜ ins.
TENDER.	
Tank	Water bottom.
Frame	12-in. channels and plates.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,500 gals.
Coal capacity	16 tons.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

IV.

(For previous articles see pages 154, 200 and 250.)

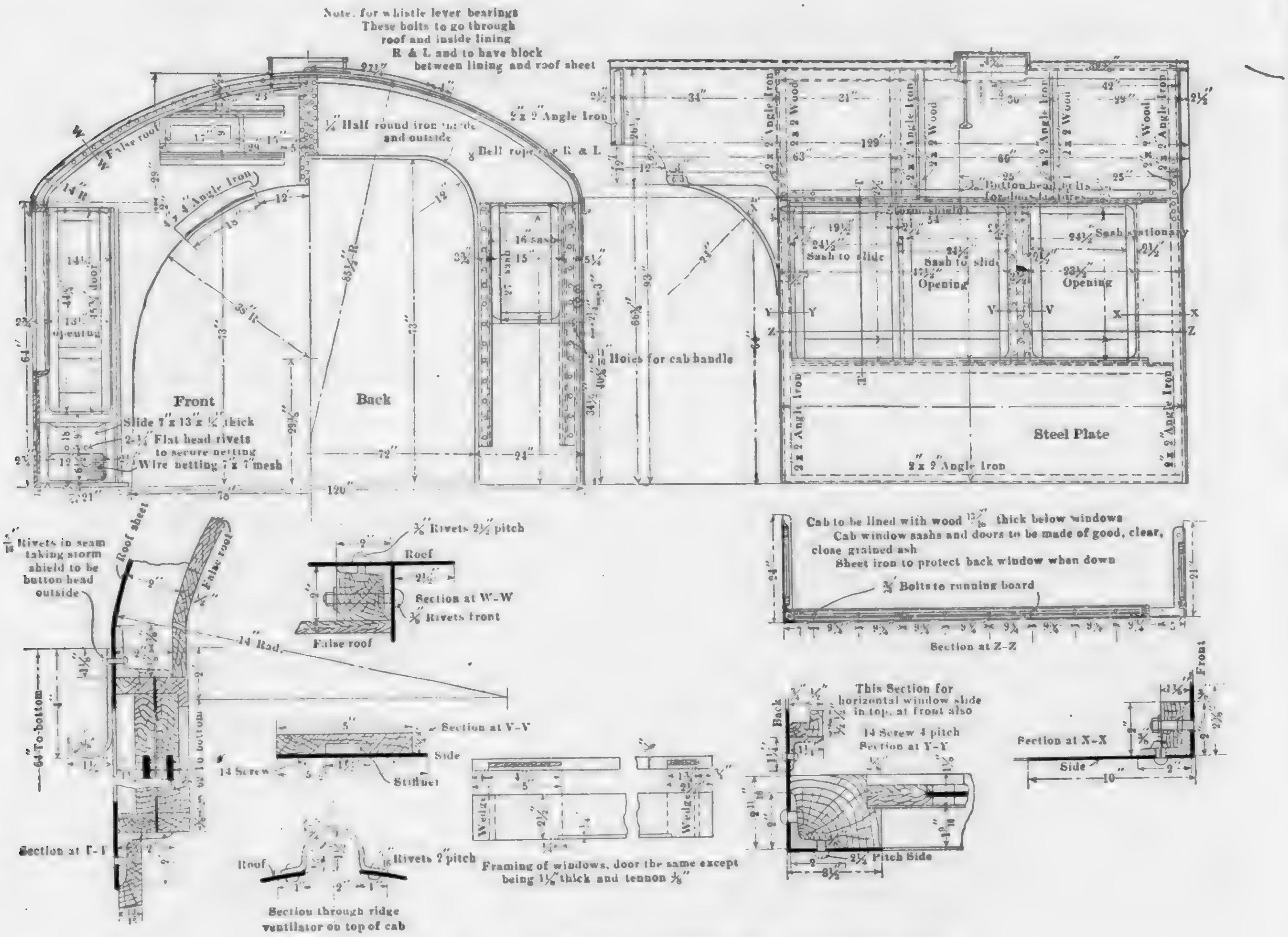
CABS.—The cabs of all four of the standard types are of the same general design, all being of metal with wooden roofs, the frames being of 2-in. angles, the sheets being of 7-lb. steel. The only essential variations are confined to the fitting of the cabs to the different boilers. All of the cabs are 120 ins. wide, and all are 90 ins. long under the windows.

BILL OF STEEL.

4 pieces 60½ x 93 No. 8 steel for front and back.
2 pieces 64½ x 90½ 7-lb. steel for sides.
2 pieces 63½ x 70 7-lb. steel for front of roof.
2 pieces 66½ x 70 7-lb. steel for back of roof.
The angles for the frame throughout are 2 x 2 in.

All of the cabs are braced to the back heads of the boilers by means of two diagonal rods 1 in. in diameter. They are secured to the boilers by means of 4 x 4-in. angles, 18 ins. long.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD CAB FOR PASSENGER LOCOMOTIVES—HARRIMAN LINES.

The designs are sufficiently alike to permit of illustrating the construction with one drawing, which is that adapted to the passenger locomotives which are of the Atlantic and Pacific types. These cabs have ridge ventilation in addition to the trap ventilator through the roof. The windows are large, the side windows having three sashes, of which the forward one is stationary while the others slide. The cabs all have 9 x 17-in. slide windows in front over the boiler. The glazed doors opening on to the running board are 13½ x 44¾ ins., each having a 6½ x 12-in. wire netting opening, covered with a slide of steel plate. The rear windows of the cabs are 16 x 26 ins. over the sash. The details shown in the drawing, together with the section through the roof, show the construction of the frame and the attachment of the wooden portion. It will be noticed that a space of 2 ins. is provided between the ½-in. false roof of wood and the outer steel roof. The cabs have 3-16-in. wooden lining below the windows. The bill of steel for the cabs of the Atlantic and Pacific types shown in the engraving is as follows:

TROUBLES OF LONG AGO.—In the old days during zero weather we would frequently have a number of rails broken in a single night. I recollect we had 255 rails broken in one night between Cincinnati and Cleveland, when the thermometer made a drop from 40 deg. above to 10 deg. below zero in fifteen or eighteen hours. We have seen the wonderful advance made since the introduction of steel rails and steel-tired car wheels. In the old days it was not anything unusual to find a broken car wheel in a train when the thermometer dropped suddenly; and the old pumps on the side of the boiler would sometimes freeze up and the whole road would be tied up over night. All that has been overcome, and we never hear of anything of the kind. It seems marvelous what was accomplished in those days of train despatching and the movement of trains by telegraph with so many difficulties to overcome. Some of the younger generation of railroad men can scarcely realize the trials and tribulations of railroading thirty years ago.—*Mr. C. S. Rhoads, before New York Railroad Club.*

DOES EDUCATION OF FIREMEN PAY?

BY B. P. FLORY,
MECHANICAL ENGINEER, C. R. R. OF N. J.

There has been considerable discussion in the technical press lately as to whether it pays to educate firemen, and, in fact, the other employes of the company, as hostlers, shop apprentices, etc., on whom the road has to (or should) depend for the making of engineers and firemen.

While the general tendency seems to be in favor of some scheme of education, yet a number of the railroads have not yet decided in their minds exactly what the benefit will be to their individual systems.

The writer last summer had occasion to make some coal and water tests, and thought that the results might prove interesting to the railroad world at the present time.

The engine selected was an Atlantic type, cylinders 19 x 26 ins., with American balance slide valves; working pressure, 200 lbs.; weight on drivers, 100,220 lbs.; diameter of drivers, 84¼ ins.

The runs were made between Jersey City and Philadelphia, with four cars on most of the trains, the distance being 180.8 miles for the round trip.

When starting the test the engineman and the fireman were instructed to run and fire the engine in their usual manner.

The first tests the fireman had a heavy fire, and kept the engine blowing off a great part of the time.

The record of the first test is as follows:

Date. 1904.	Weight Train (Tons.)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal (lbs.)	Water, (lbs.)	Coal, Per Ton Mile.	Water Per Ton Mile.
July 27	162.13	46.41	192	4-7-00	11,409	78,461	.390	2.67
July 28	171.58	45.63	201	4-9-05	11,224	76,808	.352	2.47
July 30	190.7	46.09	194	4-8-30	11,956	77,910	.318	2.13

After the above tests were completed, we got at this fireman and gave him instructions how to fire, using a light fire in starting and firing light all the way. That this made an appreciable difference is shown by the following tests:

Date. 1904.	Weight Train (Tons.)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal, (lbs.)	Water, (lbs.)	Coal Per Ton Mile.	Water Per Ton Mile.
Aug. 29	170.0	45.24	193	4-13-25	7,952	72,398	.259	2.38
Aug. 31	174.6	47.43	188	4- 1-45	9,385	72,398	.297	2.29
Sept. 2	170.5	46.3	189	4- 3-50	8,319	71,295	.270	2.32

It will be noted that the coal consumption went down from an average of 11,530 lbs. per round trip, or .353 lbs. per ton-mile, to an average of 8,552 lbs. per round trip, or .275 lbs. per ton mile, a saving of 22.1 per cent.

On the second trip of this latter series of tests the fire had not been properly cleaned by the hostler before leaving, and it was necessary to do this at Philadelphia, which was not done on other runs.

This fireman was counted as a good fireman for keeping up steam, but he evidently did not try to save coal.

That he had kept up his record made in the second series of tests is shown by a third series of tests which were conducted lately. The results are as follows:

Date. 1905.	Weight Train (Tons)	Average Speed M. P. H.	Steam Pressure.	Total Running Time.	Coal, (lbs.)	Water, (lbs.)	Coal Per Ton Mile.	Water Per Ton Mile.
Apr. 24	170.7	46.47	182	4- 6-00	9,561	73,316	.313	2.37
Apr. 25	168.6	47.33	181	4-15-00	8,265	72,765	.271	2.38
Apr. 26	179.5	46.74	183	4- 4-30	7,679	72,397	.236	2.23

The weather during these last tests was colder than the second series, and more variable, which accounts for different consumptions of coal on the various days. Even with this against the test, the average coal consumption per round trip was 8,501 lbs., or .273 lbs. coal per ton mile, which is slightly less than on the second series of tests.

These tests and the results obtained have done the company a great deal of good, in that they have stimulated other firemen to try to equal this record. I do not think that this is an individual case, and it is safe to presume that the same conditions will be found on other roads, especially on those using anthracite coal. A saving of 2,500 lbs. coal per day, or of even 1,000 lbs. of coal a day per engine, means something to a company when one remembers how large a per cent. coal forms of the operating expenses of a road.

NECESSITY FOR GREATER BRAKING POWER IN FREIGHT SERVICE.

An important opinion on the need for greater braking power on freight cars was expressed before the Master Car Builder's Association by Mr. F. M. Gilbert, mechanical engineer of the New York Central Railroad.

A proper consideration of acceleration and velocity, the prevailing higher speeds and heavier trains and the necessity for faster schedules, suggest that it is time that we look at the question of retardation and devote some time and thought to the question of how to absorb the energy of our high-speed heavy freight trains in less time than is now possible with the braking power we are using. In view of the existing conditions the writer cannot see that any arguments are required to show that we do need greater braking power on freight cars.

From the crude state of the air brake apparatus it is useless to describe the ideal conditions—where the braked power should automatically change with the loads carried by the car. So far as the writer's knowledge goes, no apparatus has as yet been developed that will accomplish this satisfactorily. We must therefore confine ourselves to getting the highest safe percentage of the light weight of the vehicle.

The matter then resolves itself into the questions:

1. Can we provide greater braking power on freight cars without introducing complications that would be detrimental to the equipment?

2. If we can provide this increased braking power without detrimental effect upon the equipment, how can it best be done cheaply and with the fewest complications?

The general practive to-day is to brake freight cars to 70 per cent. of their light weight. This 70 per cent. when corrected for the cylinder effect absorbed by the brake gear will be reduced practically 20 per cent. We therefore arrive at the point of application of brake shoes with 80 per cent. of 70 per cent. of the light weight of the car, which is 56 per cent. of the light weight of the car.

If we assume for 100,000-lb capacity cars a light weight of 38,000 lbs., we have 56 per cent. of 38,000, which equals 21,280 lbs. If we add to the light weight of the car its capacity, plus the 10 per cent. permissible overload, we have 38,000 plus 100,000 plus 10,000, which equals 148,000 lbs., and the per cent. of total weight braked is 21,280 multiplied by 100 and divided by 148,000, which equals 14.37 per cent. This braking power on a straight, level road does its work fairly well, but it is not sufficient on grades and curves, where the distance in which stops must be made is shorter.

The writer is of the opinion that freight cars can be figured to be braked at 100 per cent. of their light weight without injurious results to the equipment; this when corrected for the power absorbed by the brake gear will reduce the actual braked weight to about 80 per cent. of the light weight of the car.

The three principal factors associated with the air brake that are productive of injury to the equipment are:

1. Lack of simultaneous application and release of the brakes on the various vehicles constituting the train.

2. Lack of equal percentage of braked weight on the various vehicles constituting the train.

3. Lack of maintenance in proper repair of the air brake mechanism of the various vehicles constituting the train.

None of these factors will be affected one way or the other by the recommended increase in brake power, except the question of repairs, which will require more attention.

The benefits to be realized from the higher braking power are:

The ability to stop trains in a shorter distance; hence the ability to approach yard limits, meeting points, etc., at a higher velocity, thus enabling faster time to be made over the respective divisions.

Owing to the large number of freight cars on which the levers are proportioned for 70 per cent. at 50 lbs. equalized cylinder pressure, I am of the opinion that the proper way to get the increased braking power is by raising train-line pressure the proper amount.

Our air brake friends will probably say that triple valves designed for 70 lbs. train-line pressure will not work satisfactorily with higher pressures; they will also probably say that the increased leakage from train pipes under the higher pressure will overtax the pump. The answer to these objections it appears to me to be that the triple valves should be modified so as to work satisfactorily and the train pipe should be kept tight. As the matter now stands we are not securing the results from air brake apparatus that we should.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

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G. M. B.

(To be concluded.)

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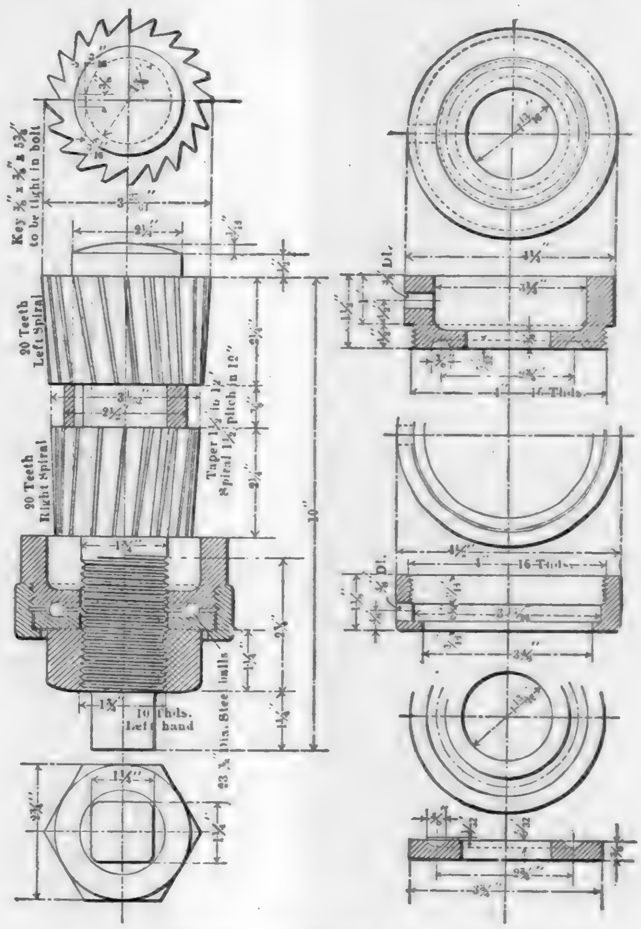

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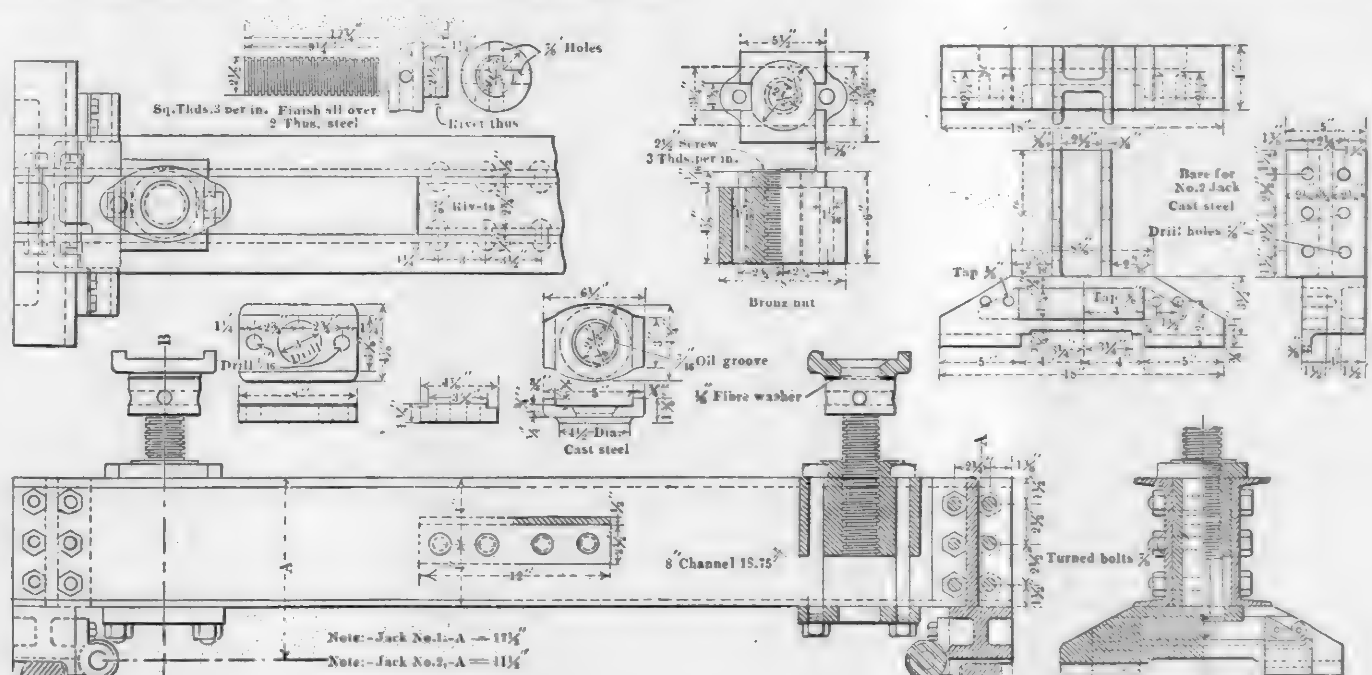

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None of these factors will be affected one way or the other by the recommended increase in brake power, except the question of repairs, which will require more attention.

The benefits to be realized from the higher braking power are:

The ability to stop trains in a shorter distance; hence the ability to approach yard limits, meeting points, etc., at a higher velocity, thus enabling faster time to be made over the respective divisions.

Owing to the large number of freight cars on which the levers are proportioned for 70 per cent. at 50 lbs. equalized cylinder pressure, I am of the opinion that the proper way to get the increased braking power is by raising train-line pressure the proper amount.

Our air brake friends will probably say that triple valves designed for 70 lbs. train-line pressure will not work satisfactorily with higher pressures; they will also probably say that the increased leakage from train pipes under the higher pressure will overtax the pump. The answer to these objections it appears to me to be that the triple valves should be modified so as to work satisfactorily and the train pipe should be kept tight. As the matter now stands we are not securing the results from air brake apparatus that we should.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

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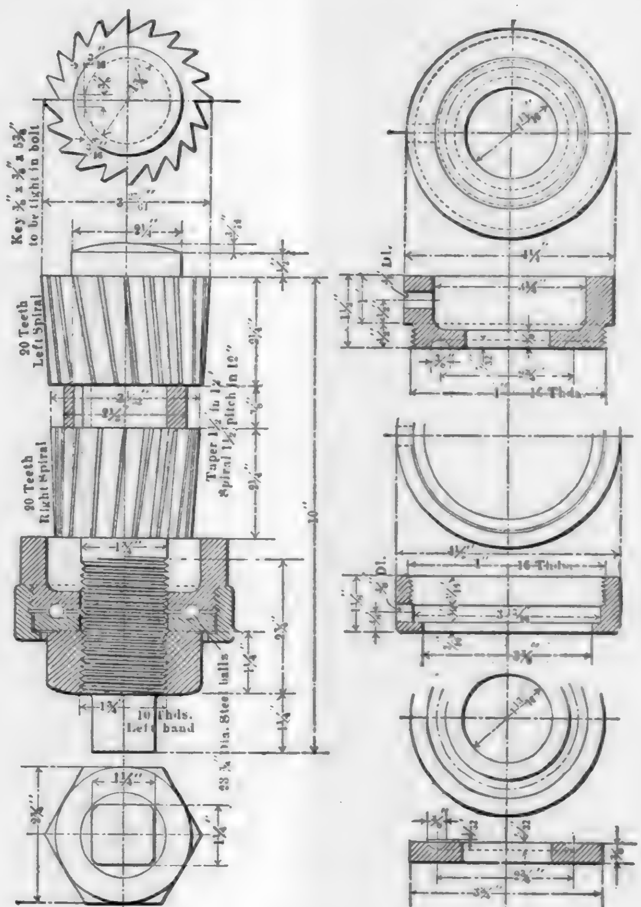

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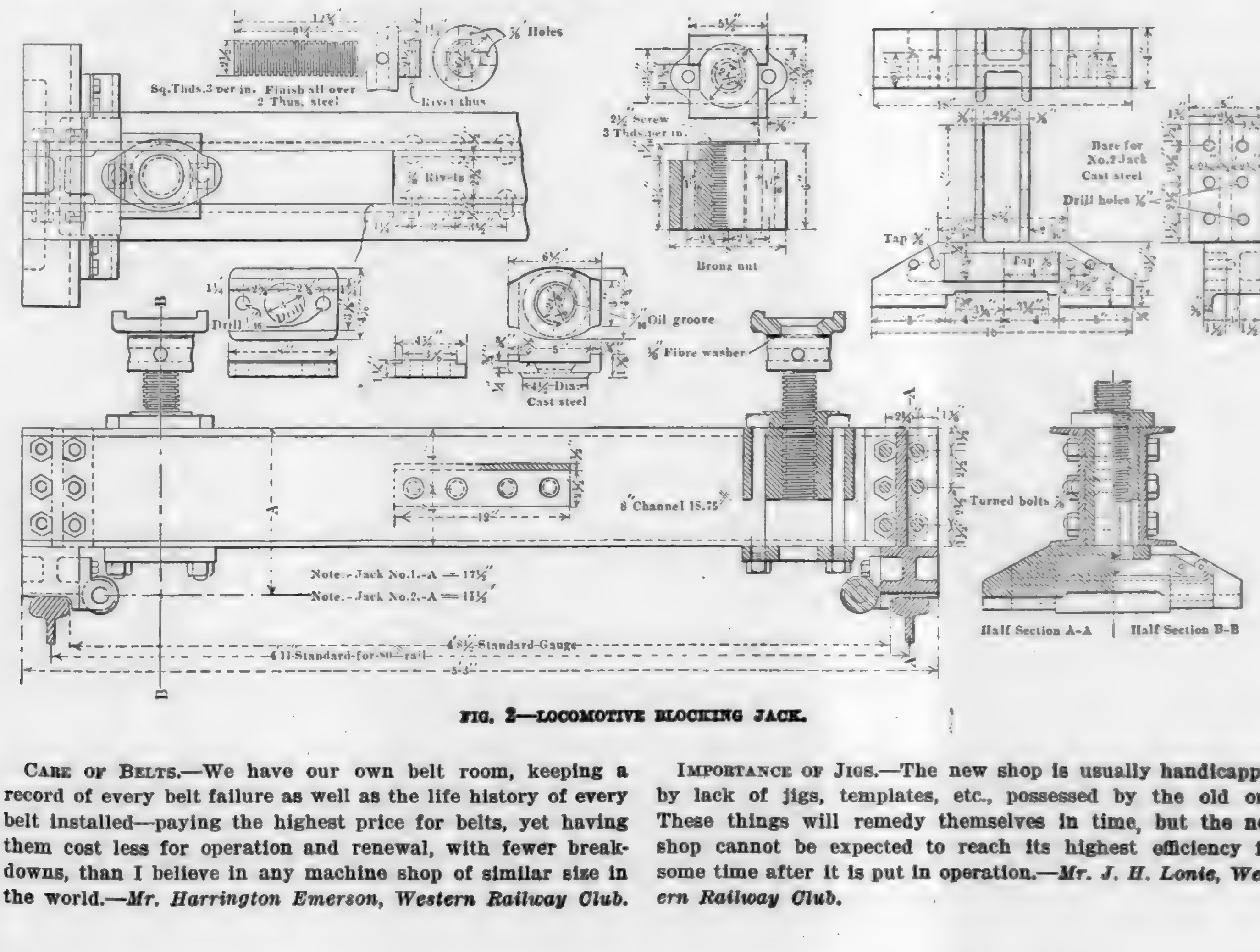

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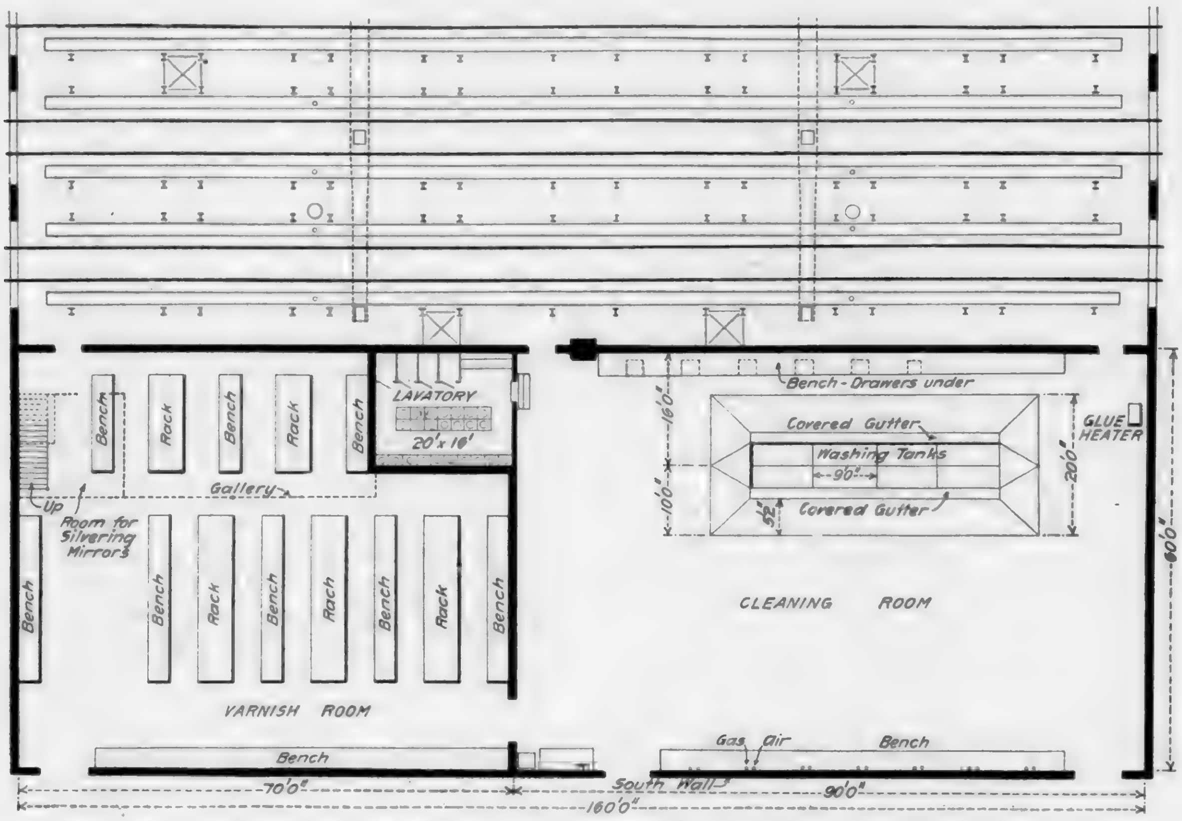
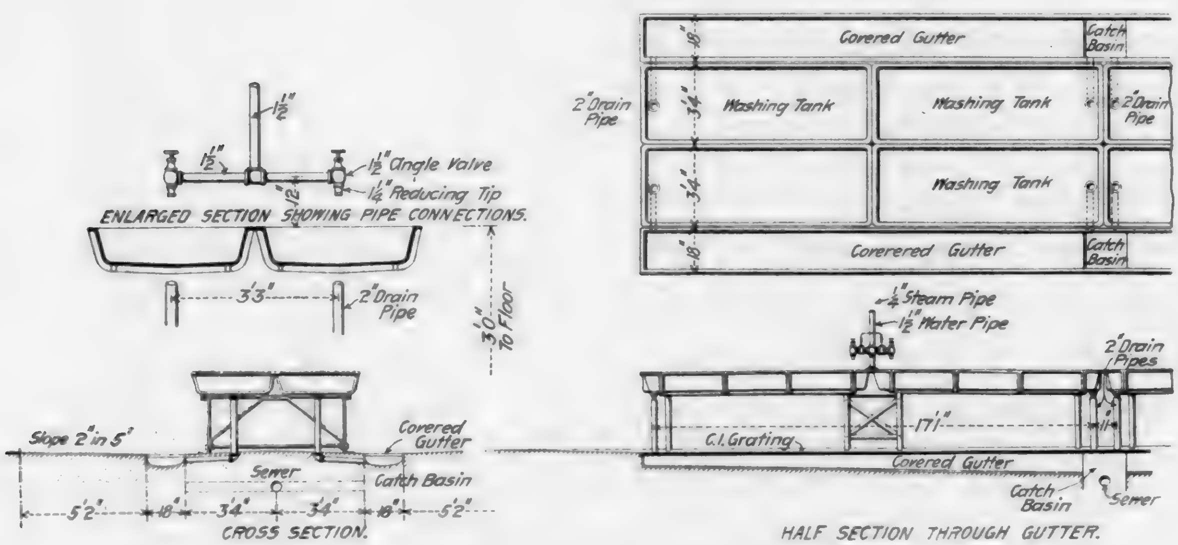
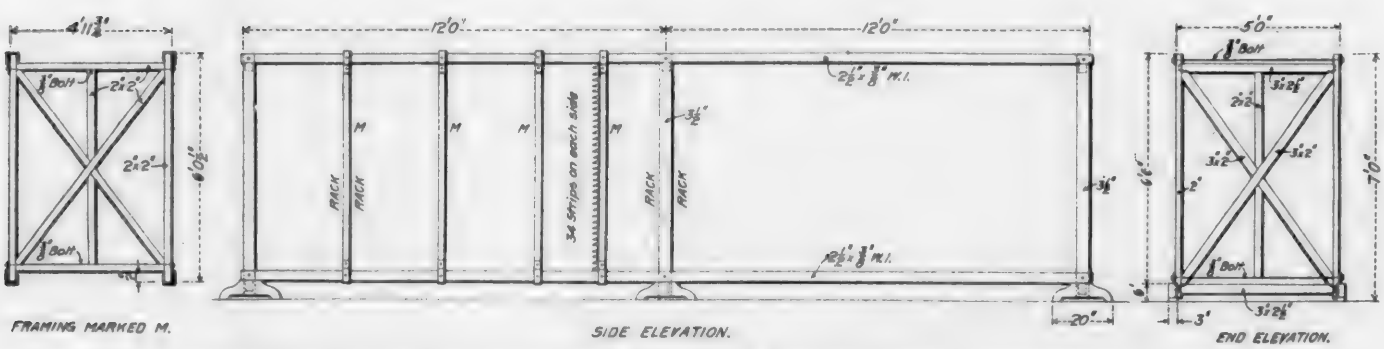


DETAIL PLAN OF SOUTH END OF THE PASSENGER CAR PAINT SHOP, SHOWING ARRANGEMENT OF CLEANING AND VARNISHING ROOMS.

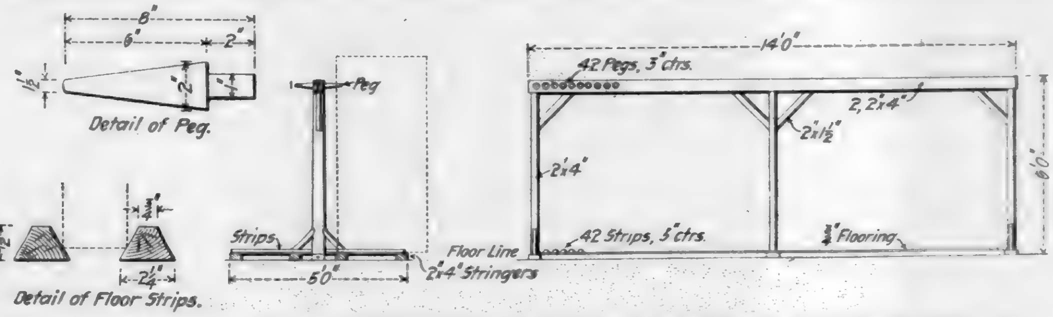


DETAILS OF THE SECTIONAL WASHING TANKS.

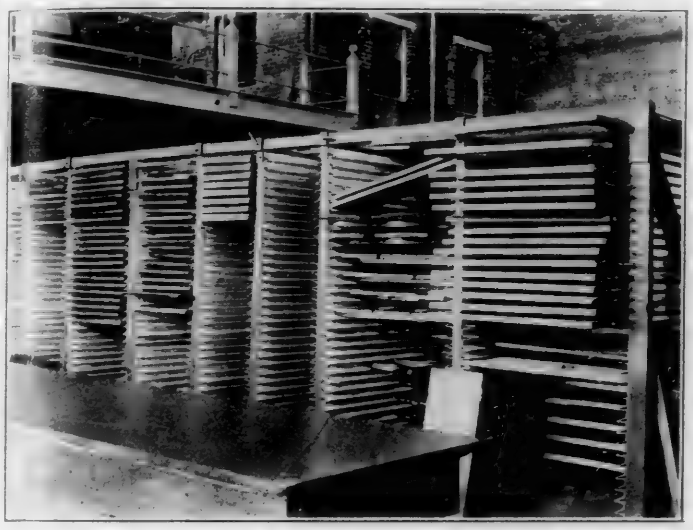


CONSTRUCTION OF THE ADJUSTABLE RACK SYSTEM FOR CARRYING FRESHLY VARNISHED SASH, ETC.

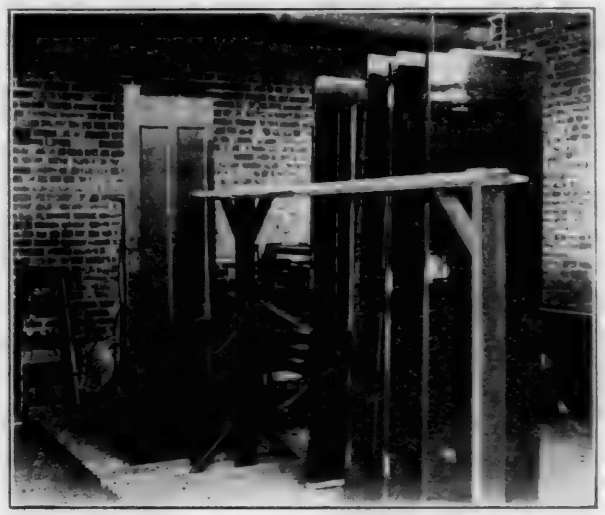
COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



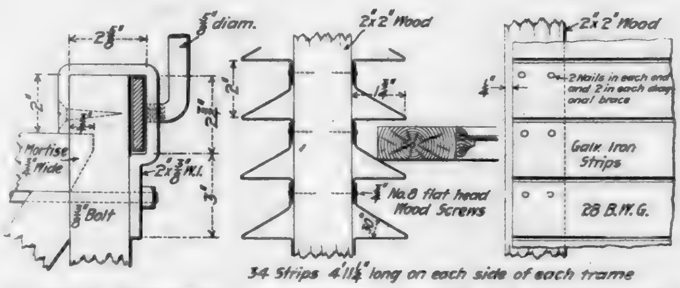
DETAILS OF ARRANGEMENT AND CONSTRUCTION OF THE RACK SYSTEM FOR SUPPORTING FRESHLY VARNISHED DOORS.



ADJUSTABLE SYSTEM OF RACKS FOR STORING FRESHLY VARNISHED SASH AND BLINDS.



STANDING RACKS FOR STORING FRESHLY VARNISHED DOORS.



DETAILS OF THE SPECIAL CORNER-PIECE CLAMPS FOR SECURING THE STANCHIONS AND OF TRIANGULAR GALVANIZED IRON SUPPORTING STRIPS.

PASSENGER CAR PAINT SHOP VARNISH AND CLEANING ROOMS.

The varnish and cleaning rooms of the passenger car paint shop at the Collinwood shops of the Lake Shore & Michigan Southern Railway are especially well arranged. In the cleaning room, which adjoins the main shop on the south end, is to be found a novel system of washing tanks, which is used in the washing of sash and other parts of the woodwork of passenger cars under repairs. The question of supplying sufficient tank room for this work on so large a scale and in such a manner that it shall be easily accessible, has been very successfully met by the system shown in the accompanying engraving. An interesting design of sectional tanks or tubs has been originated which provides not only simplicity of construction, but also ease of repairs when same is necessary.

There are eight of these washing tanks or tubs, each of which is built up of sections, as shown. Each tank consists of three middle sections and the necessary two end pieces, all of cast-iron, which are bolted together, making a complete tub of great strength and durability. This method of erecting them effected a very material saving in the pattern work for the castings, and if by chance any tub is broken, a new section may be bolted in place of the broken one with comparative ease. The method of erecting them, as well as of supporting them upon the iron framework stands, is well shown in the drawings.

In front of each row of washing tanks is located a covered gutter for draining the drip from washed pieces to the sewer. The floor slopes toward this gutter for more than 5 ft. back from it. Each tub is piped up for water supply and also with a steam connection for delivering heated water; this is accomplished by injecting the steam, from the ¼-in. pipe, as shown, into the water pipe, while the cold water is running from the tap, the steam being led into the water pipe through a special mixing connection in a tee fitting.

Another feature which is of interest is the system of racks used in the varnish room for storing window sash and blinds while drying. This arrangement of racks provides a most efficient means for storing the entire equipment of a car while drying, so that the least possible amount of room is required. It consists of a long framework of iron bars, as shown in the accompanying engraving, with adjustable stanchions, which may be arranged to accommodate any width of sash or blinds. The stanchions, or movable partitions, are merely slid along the iron bar guides, and when properly spaced, are clamped securely by a binder at each corner.

The plan of the varnish room indicates the locations of these racks, of which there are three, each 24 ft. long and 5 ft. wide. The peculiar shape of the supporting strips is such as to carry a sash by contact at a corner only, so that the freshly varnished surface is not interfered with. When the sizes of sash change the stanchions are adjusted to the particular position which will accommodate them and are clamped there by the special corner piece clamp. These racks are each located between the varnishing benches, so that the work may be placed directly in the drying rack after varnishing.

For the support of freshly varnished doors a different system of racks is made use of, as shown in the additional photograph and detail sketch. This is a standing rack, consisting of a floor frame piece with strips running crosswise, having

beveled edges; above this is erected an elevated longitudinal supporting stringer with projecting taper pegs. Then, as shown in the photograph, the procedure is that of resting a door between two of the strips on the base and between two corresponding pegs above; in this way the door will be supported entirely by edges and the freshly varnished surface is protected. Each of these two door racks is 14 ft. long and the elevated supporting stringer is located 6 ft. above the floor. Each rack has a capacity of 54 doors upon either side of the stringer, making the total capacity 108 doors.

RAILROAD SHOPS.

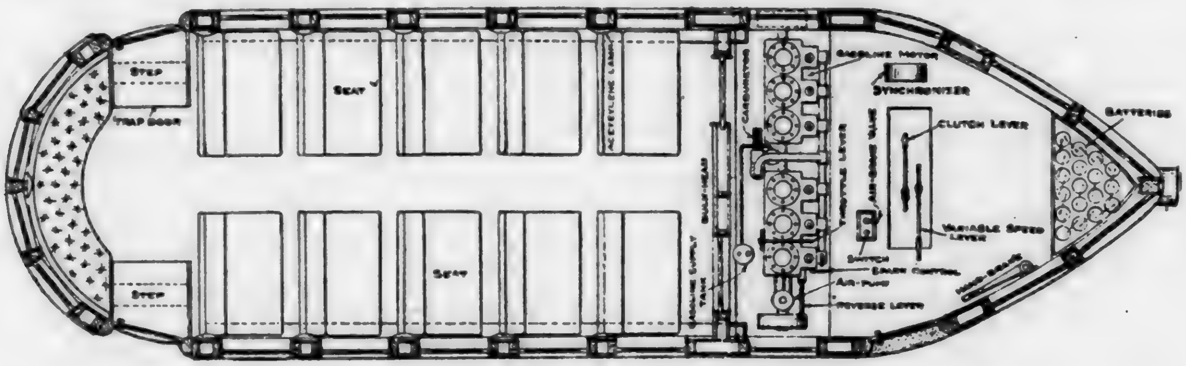
In discussing the report of the Committee on Shop Layouts before the Master Mechanics' Association, Mr. F. F. Gaines made the following observations:

The report seems to question very strongly the advisability of large shops or the use of a single shop for a railroad system. The large shop is no innovation whatever. The Pennsylvania Railroad shop at Altoona, which has been in existence for a great number of years, is a fair example of large shops. The present output of our Reading shops, where all the heavy repair work for the road is done, has been brought up in the past year to an average of three engines per day, and will be a little over 800 engines for the year, an increase of 22 per cent. over the previous year, and this has been done with a notoriously old tool equipment, and only a sufficient number of tools to operate 48 out of 68 pits; in other words, the erecting shops, which are in two bays, have been divided into 12 pits to each corner, which are being operated, and the remaining pits used for storage purposes on account of lack of sufficient machinery to run them. On the basis of 48 pits we are getting about an engine and a half per pit per month.

Referring to the articles from the AMERICAN ENGINEER (by Mr. R. H. Soule), which are published as an appendix to the committee's report, there is considerable exception to be taken to them. Tables of outputs, as given, are valueless unless considerably more is known about the conditions under which the output is made.

The character of traffic, grade, ballast, curvature, water supply, weight of engine, etc., vary for each locality. For instance, on a recent trip of inspection by some prominent officials, a certain shop located in a territory with a good water supply was very highly commended for its output on the unit basis. The average cost of engines repaired, however, was only from $300 to $350 per engine, or about one-fourth cost per engine at our Reading shops. During the past year the average cost of engines receiving general repairs was slightly under $1,500. This may seem high, but the power had become run down considerably, and the majority of engines required heavy boiler work, so that while apparently high it is really a reasonably low figure, it being about the same as that for the Central Railroad of New Jersey, as the average cost per engine varies only a few dollars from the average cost per engine on the latter road. This shows the fallacy of comparing output of shops in different localities on the unit basis.

The proper proportion of floor area for each department, based on the number of stalls, is also worthless when simply tabulated without reference to conditions. A majority of the shop layouts are deficient in floor area for machine tools and boiler work. The newer heavier power requires much more machinery to obtain the same output as was previously accomplished when engines were small. Higher steam pressures have very noticeably decreased the life of flues and fireboxes, and many recently built shops are preparing to overcome this defect by extensions. As being of interest in this connection I have tabulated the present area and the area that will exist



PLAN OF GASOLINE MOTOR CAR—UNION PACIFIC RAILWAY.

GASOLINE MOTOR CAR.

UNION PACIFIC RAILWAY.

A light motor car designed and built under the direction of Mr. W. R. McKeen, superintendent motive power of the Union Pacific Railway, has been in service on that road since April 1 of this year. It has met expectations to such an extent as to lead to the decision to build six more of a larger capacity. The experimental car is now in regular service at Portland, Oregon.

This car is 31 ft. long and seats 25 passengers. It is mounted on a four-wheel specially designed truck, and weighs a little over 20 tons. The accompanying floor plan shows the shape of the car and the interior arrangements. A six-cylinder 100 h.-p. engine drives the forward axle by means of a mechanical chain drive with several gear speeds, the speed of the engine itself being variable through a wide range. A "synchronizer" facilitates the speed changes. A reverse throttle spark lever and emergency spark cut out and air brake valve are all arranged conveniently for the operator. Six cells of battery supply current for a "make and break" spark device.

This car is designed for service on grades as steep as 4 per cent. and for frequent stops, its maximum speed being about 35 miles per hour, but by changing the gear ratios it may be run at 60 miles per hour. Compressed air is used in starting, and the acceleration is remarkably rapid. For the first 50 ft. the acceleration is slower than that of an ordinary electric car, but from 100 ft. it is very rapid. On a level or grade of 25 ft. per mile the car will start on the high speed direct connected, without the use of gears. One operator handles the car easily. It will run in either direction. The vibration and noise of the engine are not noticeable when running, and the car is reported to be entirely satisfactory.

It has been running experimentally and in regular service since last April, and ran with its own power from Laramie to Salt Lake City early in May, making the 2,095 miles with entire satisfaction. Since it first started the car has not been out of commission and has not required more than slight running repairs. It has hauled a standard mail car of 52,100 lbs. up a 1.6 per cent. grade at the rate of 11 miles per hour. It has also been tried on a 7.8 per cent. grade (a coal shute trestle), where it was stopped and started repeatedly.

when the present extensions, which are now under way, are completed at our Reading shops:

Shop.	Original area. Square feet.	Additional area. Square feet.	Total area Square feet.	Area per pit as revised.
Erecting, 68 pits, two bays, 740 x 70	103,600	......	103,600	1,523.5
Machine, one bay, 740 x 60	44,400	Extension, 400 x 250 100,000	144,400	2,123.5
Boiler, two bays, 400 x 120	48,000	Extension, 220 x 170 400 x 50 57,400	105,400	1,550.0

In a great many cases the blacksmith shop is used for both car and locomotive forgings. The use of steel castings for many locomotive parts, instead of forgings, and the manufacturing of other parts on turret lathes and special machines for bar stock, has greatly reduced the necessary output of this department, so that while the Reading shop, having an area of 37,360 sq. ft., or 525 sq. ft. per locomotive pit, is apparently small, it has been found from actual experience to be ample and with a good margin of reserve.

A sufficient number of cranes to properly handle the work should not be overlooked. In the older shops, which were not equipped with overhead cranes, each machine handling work of any size was provided with an air hoist or other lifting device for handling the material from the floor to machine and back again. In the newer shops, with the overhead crane service, the air hoist is practically eliminated, while a very small number of cranes has to do the work formerly done by a large number of air hoists or other similar contrivances. Before the advent of overhead cranes in locomotive shops a large portion of the moving and lifting was done by hand, but since the advent of cranes no one ever thinks of doing any such work, no matter how long he may have to wait for a crane. It therefore becomes doubly important to have a very large number of cranes serving each department, and it is also desirable, in addition to overhead crane service, at particular machines to install small independent hoists, either air or electric, where there is frequent need of such service.

With the installation of new cranes that are to be put in the present shops and the present extensions that are under way the Reading shops will have the following crane equipment: In each erecting bay one 120-ton, with two trolleys; one 35-ton, with two trolleys; two 10-ton, with single trolley. The main machine shop will have three 10-ton single trolley cranes. The covered storage yard will have one 10-ton single trolley and one 10-ton double trolley. The boiler shop, with two bays, will have in the main bay one 35-ton crane, with two trolleys, and one 10-ton crane, with single trolley. In the other bay three 7½-ton cranes, single trolley. In the machine shop extension the center bay has one 35-ton crane, with two trolleys, and one 10-ton single trolley. One side bay has two 7½-ton cranes, single trolley; the other side bay two 10-ton cranes, single trolley.

The cranes operating in one bay of erecting shop, center bay of machine shop extension and the main bay of boiler shop are all on the one runway, and are not absolutely confined to territory designated. Those nearest the dividing line of each shop can be used when occasion demands in the next shop.

Telephone Data.—Mr. F. P. Fish, in an address before the Beacon Society, stated that the energy required for a single incandescent burner is 5,000,000 times as great as that required to send a message to Chicago, and that the energy required to lift a weight of 13 ounces is sufficient to operate a telephone for 240,000 years. To meet all the requirements of the service 1,000,000 trees a year are required for poles, and the average cost of every class of message is 2.2 cents. Three years ago twelve telephones for every 100 of population were considered the maximum that it was possible to supply. Now the telephone people are looking ahead to a maximum of twenty for every 100 of population.

WESTINGHOUSE COMPOUND PUMP.

BY F. H. PARKE.

The new design of Westinghouse compound pump consists of three cylinders placed vertically in tandem. The two lower ones are joined by a thin center piece, constituting the air end of the pump, and these are surmounted by a center piece and steam cylinder of the regular Westinghouse type, so that in general appearance this new pump, although somewhat longer, is very similar to the regular Westinghouse pump that has been standard on locomotives for air brake systems throughout the country for so many years. The design is very compact and, since the air end only is compound, the additional features required are so similar to the old standard that the same simplicity of operation is assured. Generally speaking, the compounding of the air end is done as follows:

The two air cylinders are of the same diameter, each having a piston suitably connected to the piston rod, which is actuated by the steam piston. These two air pistons are further connected by a drum of smaller diameter than the inside diameter of the air cylinders in such a manner that the two pistons and drum form a sort of spool. The center piece between the air cylinders fits closely about the spool, and has packing rings to prevent the passage of air from one cylinder to the other past the surface of the drum. The low-pressure air is drawn into the top of the upper cylinder and the bottom of the lower cylinder, and during compression is forced through suitable valves and passages to the annular volume formed between the spool, air-cylinder walls and center piece. The final compression takes place in this annular volume, and the air is forced out through the passages and valves in the center piece to the discharge opening. It will thus be observed that in each air cylinder both high and low pressures are single acting, but that these pressures on the air piston, as a whole, are double acting. The resultant effect, therefore, on the steam piston rod is almost the same as in the simple pump, but the air cylinder surface being twice as great as in the simple pump affords twice the opportunity for radiation of heat, and for that reason the temperature of the air discharge is considerably reduced for locomotive service.

Also by thus compounding the air end a much smaller steam cylinder can be used to operate the pump, thus causing a marked economy in steam consumption.

The present design of pump consists of a steam cylinder 8 ins. in diameter by 12-in. stroke and two air cylinders 11 ins. in diameter by 12-in. stroke, while the small diameter of the spool is 8¾ ins. It is made for a capacity similar to that of the standard 11-in. pump, which has been on the market for some years, having air and steam cylinders each 11 ins. in diameter by 12-in. stroke. Consequently the compound pump has an 8-in. diameter cylinder instead of an 11-in. as with the standard, and the steam consumption is thereby reduced to about 52 per cent. of the latter through this change alone. But by compounding the air end the capacity of the pump is increased about 16 per cent. when pumping against 90 lbs. air pressure, due to the fact that the low-pressure clearance volumes at the end of a compression stroke are filled with air at only about 40 lbs. pressure, instead of 90 lbs., as in the simple pump, and in the former case this pressure reduces to the atmospheric pressure much earlier during the intake stroke than is possible with the standard pump, consequently the volume of air drawn in at each stroke is that much greater. For this reason the saving per cubic foot of air compressed is greater than that shown by the difference in steam cylinder volumes, and from tests made on the compound pump it appears that it requires only about 45 per cent. of the steam per cubic foot of free air compressed that is required for the standard 11-in. pump. This, of course, is an immense saving of itself. But since the amount of air compressed per stroke is greater, the time required for the pump to operate is thereby diminished, and the amount of

wear and cost of maintenance are correspondingly decreased.

The air valves, valve seats and valve cages are of the same pattern as those used in the 11-in. pump, while the steam valve mechanism corresponds exactly with that of the 9½-in. pump. Also the piston rings of the two air pistons are similar to the 11-in. pump and the steam piston rings correspond to the old standard 8-in. pump, many of which are still operating on railroads. The steam and air connections are also made up of standard pieces that are now in use on the other pumps, so that by the introduction of this new compound pump the amount of repair stock required outside of that already needed by railroad shops is very small indeed.

Since the working parts are all modelled after those of the existing standards, the knowledge possessed by repair men at the present time will serve them in making repairs on the new pump without any extended extra instruction. The rules already issued for operating air pumps will in nearly all cases apply to the new pump, so that its introduction, in almost every way, will cause no trouble or inconvenience to the operating departments.

Although this pump is spoken of as the "New" compound pump, it can hardly be said to be entirely so, since the Westinghouse Brake Company, in London, have built such pumps for some years, and have them in successful operation both in England and on the continent of Europe. Therefore, it is not in the nature of an experiment as far as the design and operation of the pump are concerned. The application to American railway practice is, however, new, and several railroads have already placed them in service on trial.

The greatly increased weight of cars demanding larger brake cylinders, coupled with the greatly increased length of trains, has brought about the expenditure of a much greater quantity of air and, naturally, the requirement of a larger air pump. It was this fact that brought out the 11-in. pump. With the introduction and general adoption of the high-speed brake and high-pressure control apparatus, the main reservoir pressure was increased from 90 to 120 lbs. Consequently the work of the pump was greatly increased thereby, and the consumption of steam by the air pump has been found to be a considerable factor of importance; and the introduction of an air pump designed to give the greatly increased amount of air, and at the same time require a much less amount of steam, has been made a necessity which both the railroads and the air brake company have for some time past recognized. Such a pump must combine the requirements just outlined with the simplicity of operation and maintenance

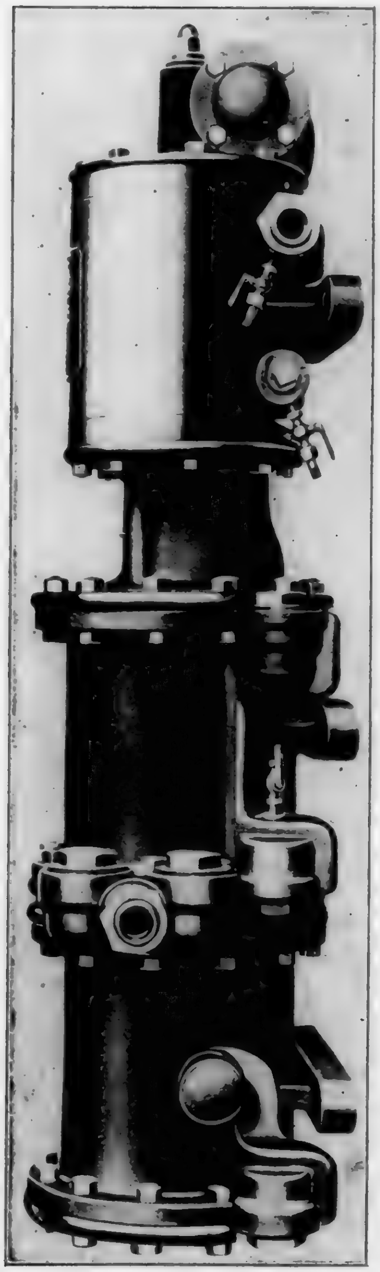


FIG. 1—WESTINGHOUSE COMPOUND PUMP.

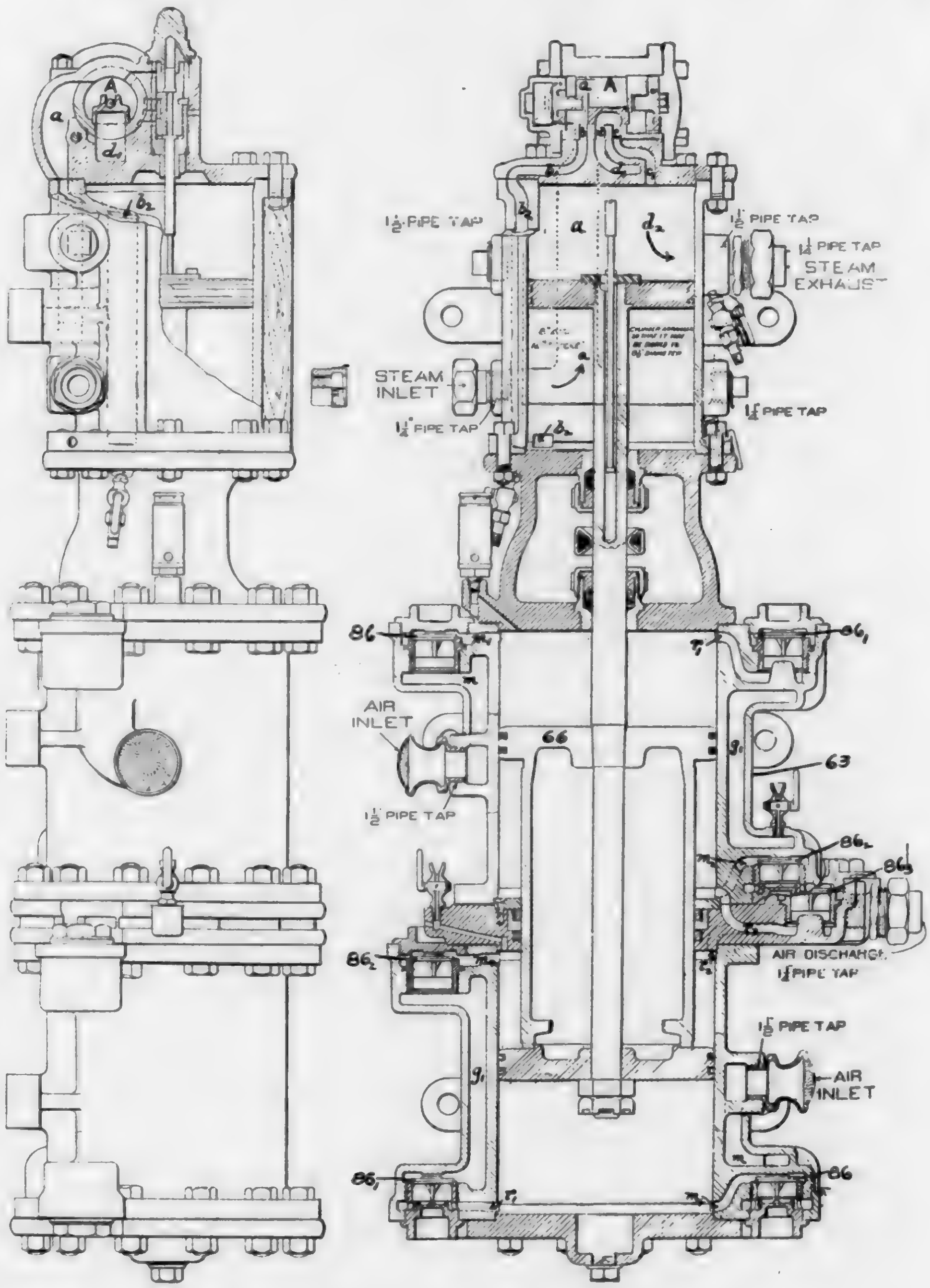


FIG. 2—SECTIONS THROUGH AIR AND STEAM CYLINDERS.

s well as the absolute reliability now had in the standard umps. Such a pump the new Westinghouse compound pump designed to be.

The cuts illustrating this article will give a clear idea of e design and operation of the pump for those who are inrested sufficiently to follow it through. The steam cylinder made both right and left hand, so that the steam and exaust connections can be made on either side, or both on one de. The lower thin center piece connecting the two air cylnders contains the final discharge valves and orifice. Each ir cylinder has a suction strainer through which the air is rawn into its low-pressure volume.

Figure 1 shows a side view of the pump, indicating clearly he position of the air valves and ports as well as the lugs for supporting the pump in position.

Figure 2 shows a front central section of the pump and a side view partly in outline and partly in section. From this ut the operation of the pump can easily be followed through. Steam enters from the governor at the steam inlet and passes through the port *a*, *a*, to the cavity *A* over the main valve, from thence it goes to either the top or the bottom of the steam cylinder in exactly the same manner as in the present 9½-in. or 11-in. pumps. It is hardly necessary, therefore, to follow this part of the operation through in detail, as the operation of the standard Westinghouse pumps is not new.

The operation of the air end, however, will be of much interest. On the down stroke air is drawn in through the upper air inlet on the left-hand side of the air cylinder; it passes through the passage *m*, receiving valve 86, *m*, to the lowpressure volume above piston 66. When the piston reaches the lower limit of its stroke and starts upward, this air is compressed until the upper discharge valve 86_1 (on the upper right-hand side of the cylinder) is raised, then the air is forced through port r_1, discharge valve 86_1, passage g_1, receiving valve 86_2 and port m_2 to the annular cavity between the drum portion of piston 66 and the cylinder 63. Since this volume is much smaller than the low-pressure volume, the air is being compressed during its passage from the low-pressure to the high-pressure volumes until, when the piston reaches the upper limit of its stroke, the air in the low-pressure clearance passages and high-pressure volume has reached the intermediate pressure of approximately 40 lbs.

During the following down stroke this high-pressure air is compressed until it raises the final discharge valve 86_3, when it passes through port r_2 and the discharge valve to the discharge orifice in the center piece between the air cylinders.

This same operation occurs in the lower cylinder when the piston goes in the opposite direction from that described above, and as corresponding passages are designated by the same letter, the operation can be readily followed through by reading over the description just given.

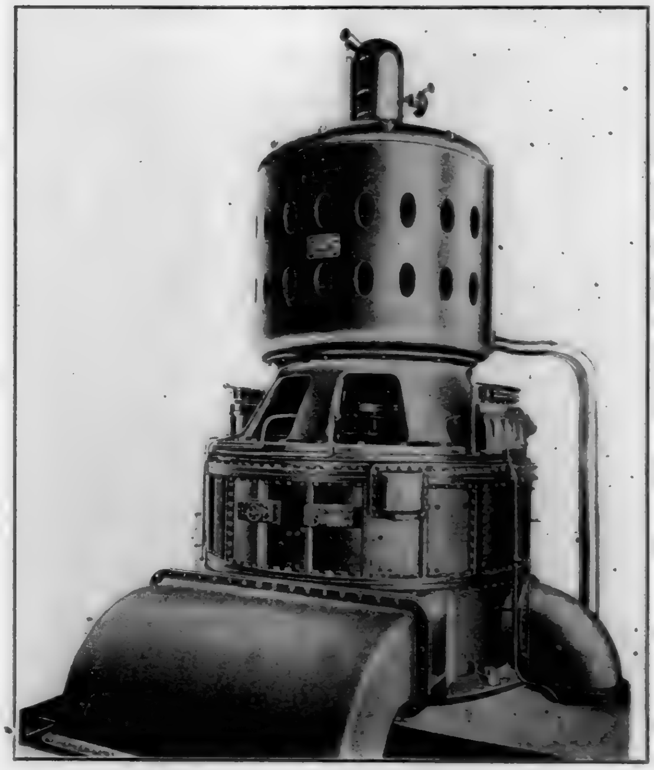
The air cylinder is lubricated by three oil cups, as shown on Fig. 2. The upper end receives its oil from the automatic oil cup placed just to the left on the upper center piece. The piston drum receives its lubrication by the oil from the cup connecting with passage g_1 in the upper air cylinder, and is drawn into the high-pressure volume by the air as it goes from the low pressure to the high. The lower end of the air piston is lubricated by the oil cup situated on the left side of the lower center piece. The last two oil cups mentioned are old style air-cylinder oil cups, whereas the other, and that in the front view of the pump, is the new automatic air-cylinder oil cup. This cup can readily be used for the upper lowpressure cylinder whenever desired.

It is thus seen that the complication due to compounding by this design is materially reduced, and all parts are made strong and durable and as nearly like standard simple pumps as it is possible to make them. In this way the great reliability that has been so prominent a feature of the Westinghouse pumps is made to apply to this pump also.

"It is better to arrive safely after dark than to arrive an hour earlier on a shutter."

CURTIS STEAM TURBINE TESTS.

The following remarkable results were obtained in a series of tests of a 2,000-k.w. Curtis steam turbine generating unit which were recently made under the direction of Mr. Frederick Sargent, of Sargent & Lundy, and Mr. Louis A. Ferguson, of the Commonwealth Electric Company. The turbine operates at 900 r.p.m., and is a four-stage machine designed in 1903 and recently changed slightly as a result of experiments conducted during the past year. The machine as tested conforms as nearly as possible to the standard four-stage machines now being produced, but is less efficient since the changes made have been confined to the buckets, while several other important changes, which are known to be desirable, could not be made in this case without entirely rebuilding the



2,000-K.W. CURTIS STEAM TURBINE.

machine. Every precaution was taken to get accurate and reliable results, and repeated tests confirm these results.

Full Load Test:	
Duration of test	1.25 hour.
Steam pressure (gauge)	166.3 lbs.
Back Pressure (absolute)	1.49 in. of mercury.
Superheat	207 deg. F.
Load in kilo-watts	2,023.7
Steam consumption per k.w. hour	15.02 lbs.
Half Load Test:	
Duration of test	0 916 hour.
Steam pressure (gauge)	170 2 lbs.
Back pressure (absolute)	1.40 in. of mercury.
Superheat	120 deg. F.
Load in kilo-watts	1,066 7
Steam consumption per k.w. hour	16.31 lbs.
Quarter Load Test:	
Duration of test	1 hour
Steam pressure (gauge)	155 5 lbs.
Back pressure (absolute)	1.45 in. of mercury.
Superheat	204 deg. F.
Load in kilo-watts	555
Steam consumption per k.w. hour	18.09
Zero Load:	
Duration of test	1.33 hour.
Steam pressure	154 5 lbs.
Back pressure (absolute)	1.85 in. of mercury.
Superheat	156 deg. F.
Steam consumption per hour	1,510.5 lbs.

UNIQUE POSITION OF SUPERHEATING.—One consoling fact in the experimental stage must be remembered—that no risk is being run of a loss, as whatever superheat is obtained is of value, and although if insufficient, the greatest economy is not obtained, the best results will have to be worked up to, as a sufficient amount of evaporative surface must be retained.—*H. H. Vaughan, before Master Mechanics' Association.*

(Established 1832).

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Nearly every successful man will give a reason to which he considers his success due. The editor recently obtained such a reason from an official whom the readers of this journal all know. It was: "When in subordinate positions I always made it a point several times every year of introducing improvements, each of which would pay my salary for the year. It did not require many years for these improvements to be traced to me, and then I was pushed ahead as fast as I could go, and perhaps faster than I ought to have gone. A young man who will do this cannot be held back on a good railroad."

COST KEEPING.

By their cost keeping systems the success of manufacturing enterprises may be measured. As a basis for estimating and conducting manufacturing cost keeping is absolutely essential. By the records of costs the superintendent is guided in his organization and administration in such a way as to intelligently introduce improvements. He is thereby able to compare the efficiency of men, machinery and methods, while without accurate knowledge of costs he would be working in the dark.

Cost keeping may be carried too far as a hobby, but there is vastly more danger of not carrying it far enough. Railroads, as a rule, fail to appreciate the value of cost records, particularly in the shops. These records necessitate providing additional clerical expense, but it is money well invested when it illuminates the operation of the shop and forms the basis of improvements. Those who are becoming interested in this subject and are engaged in establishing simple and inexpensive methods of applying commercial principles to railroad shops are sure to come into prominence, because of their success. Success cannot fail to follow intelligent efforts to improve, and railroad shops offer a broad field for this sort of improvement. It should be easy to secure new and up-to-date machinery if the possibilities of saving could be stated definitely.

THE IMPORTANCE OF TWELVE INCHES.

To meet the requirements of heavier passenger trains a certain road got some heavier passenger engines. They were larger and, presumably, better in every way than those which could not quite make the time. From the first the firemen found their work harder than before, and objected to the engines because of their size. This led to a test for fuel consumption, resulting in showing that with the same schedules and weight of trains, the larger engines were slightly more economical in fuel per ton mile than their predecessors. For a time no one could understand why the work was harder, but it was soon discovered that the tenders of the new engines required the men to carry the coal 12 ins. further than the older ones. As the men handled about 5,000 lbs. of coal per hour, this small distance became important. The remedy was easy, and was quickly applied, after which complaints ceased. This indicates the necessity for care in details of design, in order to render big locomotives as convenient as possible for the men. This is an important matter for the attention of draftsmen, and in such questions of detail draftsmen have an opportunity to show their value to their employers.

SPEED CHANGES FOR MACHINE TOOLS.

There has been a very noticeable tendency during the past year or two to increase the number of mechanical speed changes on several types of machine tools, the aim being to furnish as many changes as possible without making the mechanism too complicated or bulky, and to make these changes with a minimum loss of time and with as little inconvenience to the operator as possible. Such tools as lathes, boring mills and drill presses are, in many cases, now furnished with two, three, four and even more times as many spindle speeds as formerly, while several types of tools which three or four years ago were regarded as requiring only one speed are now arranged for two or more, as is notably the case with planers and some of the boiler shop tools.

Credit for this development is very largely due to the results which have been gained with the individual variable speed motor drive. These motors won their way into the shops largely because of the opportunities afforded by close and convenient speed regulation and brought this question forcibly before the shop managers. That an increased number of speeds, which may easily and quickly be changed is desirable is indicated by the fact that in a large railroad shop, where the machine tools were changed from the belt to the individual variable speed motor drive, the men availed themselves of the additional speeds without any great amount of instruction being given them, and the company considers the increased output due to this change as more than sufficient to have justified them in making the change.

LARGE LOCOMOTIVES.

Where to draw the line in scrapping old and light locomotives and where to draw another in building light ones are questions of importance on Western lines having many miles of branches with comparatively light traffic and poorly ballasted tracks. Good policy in one section of the country may not be good in another, where the conditions are far different.

Much has been heard lately about the policy of building light engines—of about 130,000 lbs., on driving wheels of the 2—8—0 type, and some of the Western lines are doing this and also maintaining locomotives which roads with heavier traffic cannot afford to keep up. This scrapping question is mainly one of track and traffic. If a road has not the business to require heavy locomotives, and has not the track to carry them properly, the case is clearly one requiring light engines. This, however, has been used as an argument against the modern heavy locomotive, which is said to have been unsuccessful.

Wherever traffic is heavy, heavy locomotives are absolutely

necessary, and if they injure the track, break draft gear and are generally difficult to operate and maintain, the conditions must of necessity be improved, and the locomotives must be made successful. It would be a great comfort to every one if a step backward in this matter could be taken, but it will probably never be taken, and locomotives will be still heavier rather than lighter. Heavy locomotives have led to the discovery of many weak spots, but these will be strengthened. It seems to have become axiomatic that where business is heavy locomotives must also be heavy, and the problem is not to make them lighter, but to make the heavy ones satisfactory.

Much is now being said about a return to narrow fireboxes. It is impossible to predict the effect of automatic stokers on firebox design, but unless the stoker changes the situation it seems very unlikely that a return to the old narrow firebox will be made. It seems more logical and more wise to endeavor to overcome such difficulties as have occurred with wide fireboxes, as the wide firebox is certainly necessary with the present large boilers.

In the standard locomotive equipment of the Harriman Lines no provision is made for light locomotives in future equipment. Light engines for all purposes sufficient for many years are believed to be covered by the present equipment, and who can tell what the requirements of 25 years hence may be? It is even predicted that by that time steam locomotives will be found only in museums. Certain it is that the present problem is how to build heavy, powerful locomotives and to operate them properly.

MAN FAILURES VS. ENGINE FAILURES.

A prominent railroad official recently said: "I am tired of hearing so much about engine failures. Casualties to locomotives leading to delays and grief we have in abundance, but the proportion due to actual failures of machinery and boilers is small. Our trouble is 'men failures.'"

Pooling is the worst influence ever introduced into locomotive practice, and as long as it is used it will be difficult, if not impossible, to overcome these men failures. Following pooling came the idea that that operation is best which gives each train the maximum possible number of tons. This is pernicious, fallacious and wrong. Moreover, it is expensive. What is needed is an apostle of economical train operation, who will be broad enough to see the whole operating problem at once and strong enough to compel the investment and the policy which will permit of converting transportation into a commercial transaction.

Heads of departments must conscientiously combine to produce economical results, and they must be willing to allow their personal and departmental records to dissolve into the final returns—net earnings. This involves board-mindedness, concerted effort and team work. The men failures are not confined to enginemen. There is abundant support for the statement that many of the higher officials are far removed from the problems and the men, and for the further statement that many of them do not realize this.

It is not enough to design and build locomotives and roundhouses, tracks and bridges well. It is not enough to design and equip shops well. There is another and far more difficult problem in the use of these factors, in the selection and training of the men to understand them, and who are disposed to secure from them the desired results.

With the increase in size of railroads and the growth of organizations a tendency of serious import has developed. The higher officials are necessarily further removed from the men, and to provide for this a radical improvement must be made in order to insure that at least some one else is near the men.

As armies increase in size this is provided for by maintaining the component units as small as ever. More companies, complete in themselves, are added. The generals are occupied with large questions, and they cannot and must not, deal with the individual man; but the captain is as near the men as ever. The captains are as well trained and the discipline may be as perfect in a thousand as it is in a few companies. From this standpoint to reduce men failures the railroads need more captains, more delegation (but not division) of authority, more responsibility of subordinate officials and more councils of war of higher officials.

Some of the men failures are: (1) Putting green men at work as firemen after but one week of experience on a locomotive and with no previous railroad experience. Such men will forget to put the heater on the left-hand injector, and it will come in frozen on a cold day. (2) Allowing trains to delay long at stations for baggage and mail transfer, which time must come out of the locomotive when running. (3) A policy which renders it possible for a locomotive engineer to earn more in a month than the master mechanic, who is responsible for the work of three hundred engineers, a couple of thousand shop and roundhouse men and various other responsibilities. What else but a man failure can be expected here? (4) The continued use of old shop machinery when new tools will double the capacity. (5) Depriving local officials of reasonable discretion in advancing wages and salaries to specially efficient men. (6) The tendency toward leveling men into classes with horizontal planes of cleavage by rules regulating the maximum rates of wages. (7) The pooling system and indifference to individual responsibility in the operation of locomotives. (8) The tendency toward putting the blame on some other department. (9) The lack of something to take the place of old-time apprenticeship. The too general lack of training of men in their duties and the lack of systematic recruiting systems.

These are enough for the purpose, and it is important to note that these are questions for the presidents and directors to decide. There is reason for hope that they will soon be appreciated.

SELECTING NEW MACHINE TOOLS.

Too much emphasis cannot be placed on the importance of using great care in selecting new machine tools. The price, a photograph and a specification or general description afford a basis upon which to work, but they are not sufficient. The person who makes the selection must be thoroughly familiar with the work which is to be done by the machine, and should personally inspect the various machines which are offered to determine which one is best adapted to handle the work. The first cost of one machine may be much greater than another, but an investigation may show that the increase in first cost will be offset in a few months by the increased output afforded by the higher priced tool. A photograph is often misleading, and does not enable one to study the detail parts closely. The specifications and descriptions are too often written with a view to exploiting the "talking points" of the machine and some of the more common features, which, nevertheless, may be of vital importance as far as the output or accuracy of the work is considered, are sometimes not even mentioned. Too much importance is often given to the comparative weights of machine tools. Weight means nothing if it is not properly distributed.

It is encouraging to note that some of the larger roads are placing the selection of new tools in the hands of a committee composed of those best fitted to judge the merits of the tools from a practical and theoretical standpoint. One road recently sent one of its machine shop foremen to examine the various makes of tools at the works of the builders, and was almost entirely guided by the report which he made. In these days, when rapid progress is being made in improving shop methods and new features are being added to machine tools from time to time which enable them to be more easily operated, and which tend to increase the accuracy of the work and the output, the best results cannot be obtained by considering the tools in a haphazard manner at long distance, or by leaving it in the hands of a person who is not in close touch with the development which is taking place.

COMMUNICATIONS.

A MATTER OF EDUCATION.

To the Editor:

Expecting in your July issue to note further comment on your article, "A Matter of Education," from the June issue, I find that motive power officials have missed another good opportunity to place their men in the right light.

Humanity, with all its follies, is not depreciating as fast as depicted by some of the writers on this question. Look at the matter in its right light and go to the bottom of it, and you will find what is termed in this busy day "Commercialism" in one form. Let those officials, who fear for the future and the kind of men they must use go back to the days of the old men. Were they brought up under the pooling system of engines? Was an engine cared for to keep it in shape to haul its tonnage economically?

With the coming of the large engines, we entered a new phase of operation. Have the higher officials given the motive power department the appliances necessary to meet those conditions quickly and economically, or are they still trying to handle the 100-ton engine with the same shops and tools they did the 50-ton engines? So it is with the enginemen. Are motive power men responsible for the pooling system and shortage of power that has done so much to reduce the men to the "Don't Care" system?

The old-time engineer petted his engine and worked over it. To-day your engineer looks as the men say, "For 6 o'clock and pay day."

Let us educate the engineman and, incidentally, every man in the service, but don't blame the men for what we have largely made them. If the education of the men is not to be lost or appreciated, we must see to it that the higher officials are educated, or become better acquainted with the real needs of the motive power department.

If we are to have contented and efficient men, they must have the proper tools to work with, and it is useless to prate of inefficient men and forgotten coal economy if we give men engines to work with that ought to be in the shop for repairs, and oftentimes rebuilding.

MASTER MECHANIC.

IMPORTANCE OF DRAFTING ROOM WORK.

To the Editor:

In the present day struggle to increase the out-put of the railway machine shop by the installation of larger machines, the use of special tools, and the introduction of high grade steel, the importance and possibilities of the work of the railway drafting office is largely overlooked by many superintendents of motive power. Even in the most modern and best equipped shop the earning capacity of both men and machines is seriously handicapped without proper drawings of the work to be turned out. There is little economy in keeping a $10,000 machine idle while the operator studies out dimensions from an obscure drawing or goes across the shop to get a measurement from an old broken casting. The operator's time as well as that of the machine is lost. Without the drawing the liability of errors and consequent loss by misfits and spoiled material is greatly increased. The dimensions on a well-checked drawing are much more reliable than those computed by the machinist who may not be "quick at figures."

The drafting department should be made up of competent men and should be large enough and well enough equipped to furnish complete and accurate drawings for all locomotives, cars and machines to be built or repaired. It is not enough that there be mere sketches but there should be complete and accurate blueprints of all parts as well as assembled views. Each piece should be detailed, and not too many detailed pieces should be shown on the same card. With the present division of labor there is much in favor of having each piece on a separate card with views and sections enough to make all clear and plain.

The value of a drawing depends largely upon the dimensions given; not only must they be correct but they must be plain and easily caught by the eye. The placing of dimensions on a drawing in the best possible manner requires careful thought, and the draftsman should study each drawing in order to place the dimensions not merely where they can be seen but where the machinist cannot help but see them. A few hours spent by the draftsman to this end will result in a saving each time a drawing is used and considering the number of times one is used the aggregate saving will be many times the draftsman's salary.

There is little doubt that a great many of our railroad companies, large and small, could profitably increase their mechanical drafting force by adding from ten to twenty-five per cent. more *good* men at good salaries and see to it that the shops are furnished clear, accurate and complete drawings of all work to be turned out.

Chicago, Ill.

J. C. AUSTIN.

VARIABLE SPEED FOR MACHINE TOOLS.

To the Editor:

With reference to your recent editorial, page 261 of the July issue, upon the subject of variable speeds for machine tools, the writer would suggest that the ideal method of changing speed would be some means of variation that would quickly cover the desired range of speeds from minimum to maximum gradually, rather than to have a comparatively limited number of speeds with more or less space between them. Such a condition could be fulfilled by two reversed cones with a movable disc between them. This is simply mentioned as illustrating a principle and not as a scheme for actual use upon a machine tool. Such an arrangement would give an infinite number of speeds within its limits and would be ideal as far as speed variation is concerned.

As a means of speed variation, the stepped pulley is notably deficient, as, owing to the small number of speeds obtainable, the percentage of increase or decrease from any one speed to the next one is inconveniently large. With the motor drive the use of a controller having many points reduces this percentage very materially. Consider the 20-in. lathe mentioned in your editorial; as ordinarily built there would probably be a 5-step pulley, which with the back gear would give ten speeds covering a probable range of from ⅝ to 20 in. diameter, with eight intermediate diameters at which the cutting speed will have a uniform rate; then if the limit of work diameter is to be 4 ins. only a few of the ten speeds can be used to advantage. Granting that one-half of the total number of speeds can be utilized the number is manifestly too small to operate the lathe at the best advantage. The fact that a piece of work of a given diameter can be cut at varying speeds, dependent upon the depth of cut, amount of feed, and condition of tool, makes it possible to utilize small increments of speed variation to good advantage. Even a less than 10 per cent. variation is a help if it gives the maximum speed desired. The fact is that with a large number of speeds at hand, the operator has more chance to obtain a desired speed or the best results than where only a few are available. Furthermore a good operator can usually tell by the action of the tool and the general conditions of operation when he has attained about the best speed rate that the tool will stand.

Recent interviews with three superintendents of railway shops brought out the fact that one of them had not thought much about the subject, but the other two had and wanted all they could get in the way of speeds, not that all were necessarily needed, but that the most desirable speed could then be easily obtained. Another thing in favor of a large number of running points is that the change to higher speeds is much less abrupt than where a few only are used. It is true that with special work done upon special machines a smaller number of speeds are needed than where the work is of a general character but it is equally true that small increments of variation are of advantage in either case.

J. C. STEEN, M. E.

RIVETED JOINTS.

To the Editor:

The recent boiler explosion in a Brockton shoe factory has led to much discussion in Massachusetts on the subject of riveted joints. A longitudinal lap seam in an old boiler failed, and the consequent explosion resulted in the loss of about sixty-five lives. In a general way it is admitted that a lap joint is undesirable, but its inefficiency is not fully appreciated because of the erroneous method of calculating its strength. Failures of such seams are common, and are commented upon in some such way as this: "The cause of the explosion is a mystery, for the joint had a factor of safety of 4½. A sample of the plate is to be tested."

The strength of a lap seam can be calculated with greater accuracy than that of any other joint; for the rivets carry nearly equal loads, and, in the case of the double-riveted joint, the plates

stretch practically equally between the two rows of rivets. But the load is eccentric. The tension stress must be considered as consisting of an evenly distributed one, combined with a uniformly varying one which balances a moment, consisting of the load multiplied by half the thickness of the plate. The maximum intensity of the combined stress is four times as great as that of the evenly distributed component, which has hitherto been regarded as the only stress.

Lap joints made of new material have been tested in tension machines. The plates could bend, altering the distribution of the stress until, at the final rupture, it could have been nearly evenly distributed. Upon the results of these tests calculations for the strengths and proportions of seams of this type are based. But, when that material is placed in a boiler, the most stressed edge is subjected to a load insufficient to materially alter the distribution of the load, but still is loaded beyond its elastic limit. It necessarily suffers that gradual change known as "fatigue," losing much of its elasticity, and a crack must start in time. The friction of the plates, the support of the adjoining plates and other secondary causes must now be holding together many lap joints having small factors of safety.

Have we not relied too much on the ultimate strength as ascertained by tests of specimens made of new material? Is not the only safe practice that of keeping the stress of every part of the joint within the elastic limit? And will not accurate measurements of the distortion of every part of a specimen at different loads give the information needed to ascertain what part of the load each rivet and each section of the plate is carrying? Consider, for example, the sextuple-riveted, butt joint in common use now. In designing the joint the rivets are assumed to carry equal portions of the load, but it is not known that they do. The welt strips are eccentrically loaded. Upon their thickness depends the proportion of the shearing each rivet must withstand. The outer row of rivets exerts an eccentric force, and, so far as known, may weaken the joint instead of strengthening it. It would seem that an ideal joint should have all rivets pass through both inside and outside welt strips, and that the thickness of these strips should be decreased toward the edges. A form of joint much used from ten to fifteen years ago consisted of a double-riveted lap with an inside cover strip. This strip was offset over the edge of the inner plate. We can only guess how much of the work is done by the rivets beyond the offset. If, owing to a distribution of the load different from that assumed, any parts of these joints are stressed beyond their elastic limit, cracks will in time develop in them. Then other parts will be similarly stressed and fail, and, if the boiler is kept in use long enough, the last part to fail will cause an explosion.

Lap joints are still used in domes and drums, and for circumferential seams. (A joint consisting of one welt strip outside and none inside is but a combination of two lap joints). Although the steam pressure stresses the circumferential seam but half as much as the longitudinal one, the former is severely taxed by forces transmitted from the frame and cylinders. So long as the elastic limit is not exceeded, the lap joint is perfectly safe for these purposes, but I submit that the calculations should be based on eccentric loading, even if the factor of safety has to be reduced, and that a greater pitch than is now the practice will be found more serviceable.

Waltham, Mass. G. F. Starbuck.

LOCOMOTIVE GRATES FOR SOFT COAL.

To the Editor;

I have recently come from an anthracite to a bituminous road, and, not having previous experience to fall back on, would respectfully request advice as how to secure information relating to grates for soft coal, drop grates, area of air openings in grates and the amount of grate surface which ought to be provided with facilities for shaking. You may be able to show me a short cut to the desired knowledge.

Subscriber.

Editor's Note.—The best answer to this question appeared in a paper read by Mr. J. A. Carney, before the Master Mechanics' Association last year. As this may serve also to remind others of important questions concerning grates, the following paragraphs are reproduced:

It has been demonstrated that the cheapest fuel for locomotive use is that which can be bought for the lowest prices per ton, and it rests with the railroad mechanical engineer to so design his engine to burn this cheap fuel with the least inconvenience. The ash-pan is so closely related to the grate that it is discussed in this paper in connection with grates. In designing a grate the first object is to properly support the fire; the second, to admit air enough to the fire to properly burn it; the third, to easily and effectually stir the coals and shake down the ashes, and the fourth, to be able to quickly remove the fire at the end of a run; a fifth and most important feature is to be able to quickly and easily clean the fire on the road.

The ash-pan must be tight to prevent loss of hot ashes, and yet have enough openings to admit air freely to the under side of the grates. It must have sufficient volume to carry ashes made during a trip of many hours, and should dump and clean itself with a minimum amount of labor. There should be no flat places where ash can collect and fill up to the grates. While the air openings, according to theory, need be very small, they should in practice be as large as possible and allow the passage of sufficient air to not only burn the fire but cool the grates and accumulations of ash on them as much as possible. Theoretically the air openings in the grates should be of just enough area to admit, without undue friction, a quantity of air needed to replace the hot gases drawn from the firebox.

Estimating the temperature of the products of combustion in the fire-box at 3,500 degrees F., the volume of the gases passing out of the fire-box will be about seven times as great as the air passing through the grates, due to the expansion caused by the high temperature. As all of the gases have to pass through the flues, the openings in the grates and ash pan need be one-seventh of the combined area of the flue openings. According to the above figures, an engine having 44 sq. ft. of grate area and 792 sq. ins. of flue openings, the total area of grate openings should be 114 sq. ins., with 114 sq. ins. opening in the ash-pan. In per cent., with grate area 100 per cent., this equals:

Grate area	100
Flue area	12.5
Grate opening	1.8
Ashpan opening	1.8

The use of the finger grate is somewhat more common than the box construction. The box construction is used in good-coal districts, and while roads report some trouble where the coal is fairly good, others who are using poor coal report an endless amount of trouble. The fingered grate has the advantage of breaking up as well as stirring the fire, while the box grate can only lift and lower the fire, without breaking it up. The only objection to the finger grate is the possibility of burning the ends of the fingers if they are not kept level. This can be entirely overcome by care on the part of the fireman and the shaking mechanism kept in repair. The long-fingered grate is better adapted for poor coal than the short finger. It has a more violent action on the fire, breaks it up better, shakes down ashes faster and gives a larger opening through which the fire can be dumped in the least possible time. Grate fingers less than 5 ins. long do not give as good results with coal which clinkers or which fills up the box as those longer than 5 ins., although the general practice is to run under 4⅞ ins.

Dead grates are used by seven of the roads making replies. These roads use a better grade of coal than that found in the Middle West. As a general proposition, a dead grate is not advisable, especially in the front end of the fire-box, where there is most need of a good fire, especially with wide, shallow fire-boxes. It is easy to accumulate ashes in the front, and if the fire dies and cold air gets next to the flue sheet, it is difficult to make an engine steam.

Most roads have special dumping grates, both in front and in the back end of the fire-box, and the idea has a great deal of merit, especially when it is necessary to clean a fire on the road. These grates should be shaking as well as dumping grates.

Grates should be designed so that the entire grate surface may be shaken. If it is desirable to stir up the fire in the middle of the box, why not on the sides and especially the ends? The area shaken by one lever may vary with the quality of the coal, and if the ash melts and cements the grates tight, the shaking feature is out of the question and all designs are equally bad. The grate area shaken by one lever ranges from 7.2 sq. ft. to 29.8 sq. ft. The grates with the last-named area are used with West Virginia coal and practically no shaking is required. Generally speaking, the grate area to be shaken by one lever should not exceed 12 sq. ft. Some recently built engines have the grate lever fulcrum attached to the back of the boiler head with studs. These studs are liable to pull out and it is safer to attach the fulcrum to the deck or tail-board.

It is impracticable to make grate bars wide enough to extend from one side of a fire-box to the other without a central support. This support prevents air from circulating under the fire in the middle line of the box, and there is a dead space a few inches wide from the front to the back of the fire which will clinker badly if great care is not taken in firing.

PERSONALS.

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Mr. William Alter has been appointed foreman of the car department of the Central Railroad of New Jersey, at Elizabethport, N. J., succeeding Mr. W. F. Girten.

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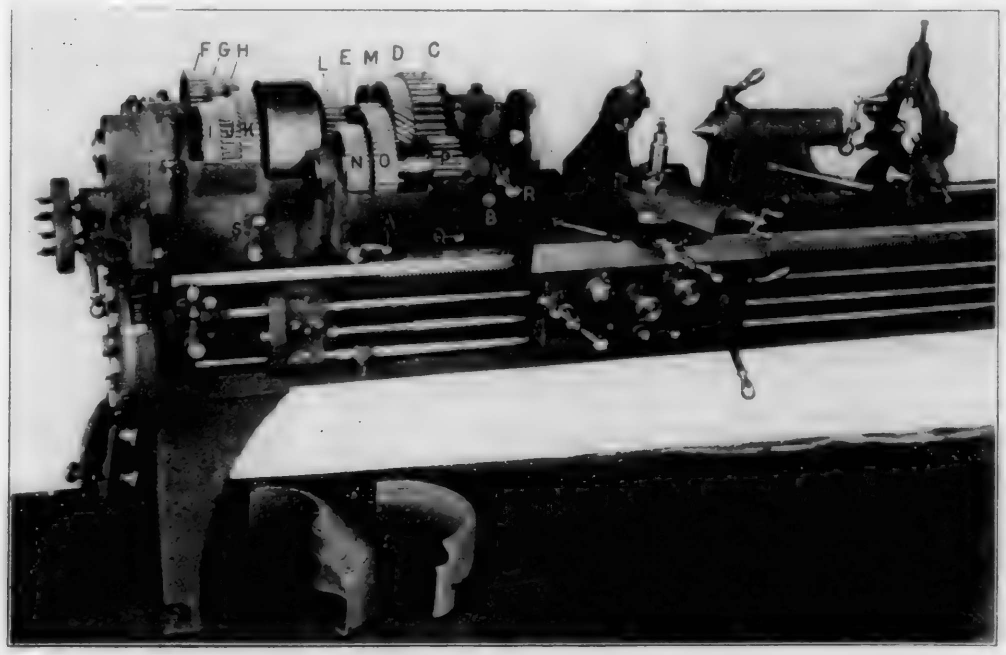

SPRINGFIELD RAPID REDUCTION LATHE.

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19-INCH RAPID REDUCTION LATHE.

A new rapid reduction lathe, having a capacity sufficient to swing a piece 19 ins. in diameter in the rough, is shown in the accompanying illustration. This lathe was carefully designed with a view to working the high speed steels to the limit of their capacity and to furnish a sufficient number of spindle speeds in geometrical progression for all practical purposes. The head stock is of very heavy proportions and ample power is provided by a 4½-in. belt over a 12-in. single face pulley which runs direct upon the spindle at a moderate speed. With a two-speed counter shaft 20 spindle speeds are obtainable as follows: Two direct belt speeds are obtained by a positive clutch operated by the handle A connecting the driving pulley to the spindle. Six speeds are obtained when the lever A is in the position shown and the face gear C is connected to the spiral gear D by a positive clutch operated by the lever B. Gear D is driven by a pinion keyed to the shaft E. Three gears, F, G and H, are mounted loosely upon shaft E and any one of them may be connected to the shaft by an internal positive clutch operated by the handle S. These gears mesh with I, J and K, which are keyed fast to the pulley.

Twelve more spindle speeds are obtained through the double back gears which are placed in front of the spindle. The face gear C is disconnected from the spiral gear D allowing the latter to revolve freely upon the spindle. Keyed to the spiral gear D are two gears, L and M, either one of which may engage with back gears N and O driving the spindle through pinion P and face gear C. It is impossible to injure gears N and O, as they are positively locked in one or the other driving position by a hook upon lever Q, which also affords means for sliding the gears from one position to the other, this lever receiving its locking and unlocking motion from the handle R, which has an eccentric projection extending through the housing in which the back gear shaft is mounted, with an eccentric bush at the other end. It will be seen that with this arrangement of gearing the higher speeds, which are used for the finishing cuts are the two direct belt speeds and the six speeds through the spiral gears which produce a smooth motion. The remaining twelve geared speeds are for roughing and for heavy cuts upon large diameters. Placing the back gears in front of the spindle relieves the caps of any strain.

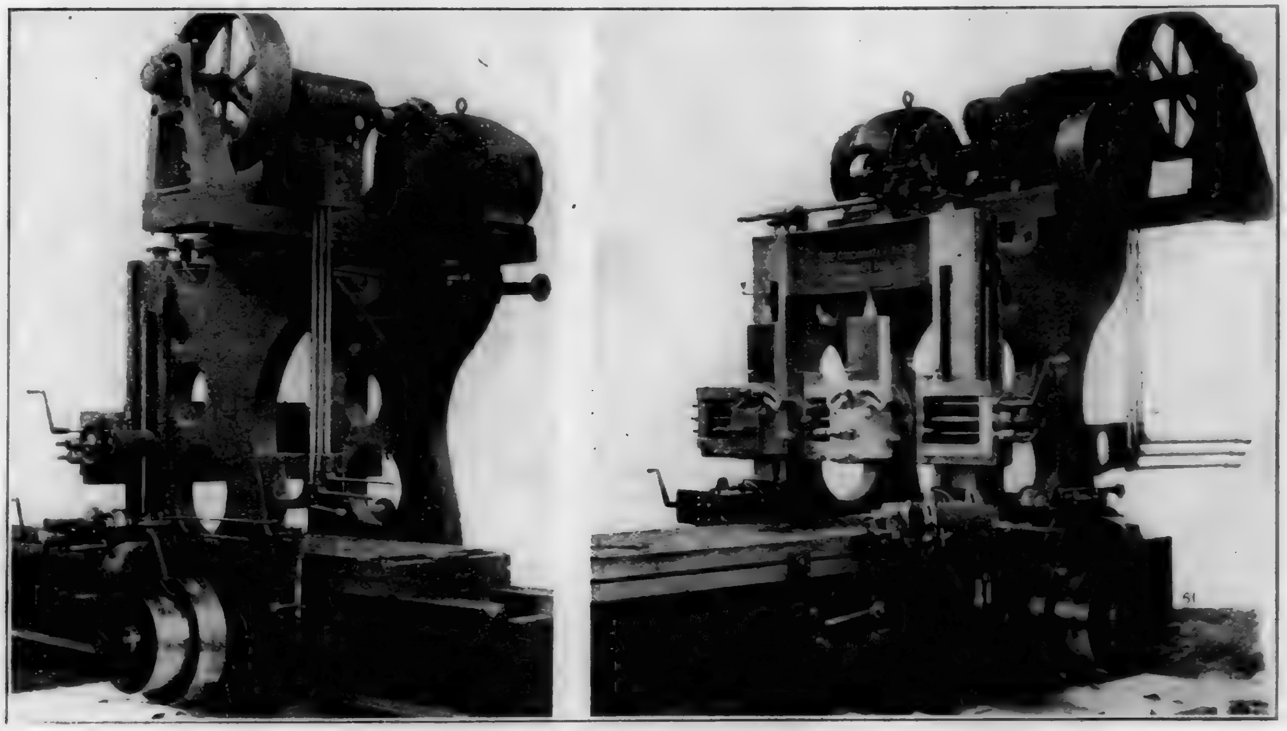
The headstock spindle is made of crucible steel with a 1 9-16 hole through it and runs in self-oiling bearings. The tailstock spindle is clamped by two bushes insuring its proper alignment. The carriage has one V and one flat bearing and has a power cross movement, the cross feed screw having a micrometer collar reading to 1-1,000 of an inch. An effective clamp is provided for the carriage for use when facing. The apron is double, furnishing two bearings for all studs, and the rack pinion has a bearing supporting it close to the rack and may be withdrawn when screw cutting. The lathe shown in the illustration is equipped with the Ideal rapid change gear mechanism, which was described on page 27 of our January, 1903, issue, but if desired it may be equipped with a positive

gear feed—giving six variations of feed—and regular change gears. The compound rest is of a heavy pattern and fitted with taper gibs to take up the wear. The screw has a graduated collar reading to 1-1,000 of an inch. The counter shaft is of simple design, having one tight pulley and two friction pulleys of an improved form. This lathe is made by the Springfield Machine Tool Company, Springfield, Ohio.

42-INCH MOTOR-DRIVEN FORGE PLANER.

The Pennsylvania Railroad has recently installed three 42-in. forge planers, two at Wilmington and one at Trenton, which have several noteworthy features. They were made by the Cincinnati Planer Company, and are of an entirely new design from the ground up. They are driven by Westinghouse 20-h.p. constant speed motors, and by means of a speed box are arranged to furnish six cutting speeds ranging from 22 to 51 ft. per minute, with a constant return speed of 80 ft. per minute. The changes in cutting speed can be made either while the machine is in operation or standing idle by means of the three levers shown at the right in the photograph. The gears in the speed box are of steel and are completely encased in a cast iron box, which holds several gallons of oil. This oil is also used for lubricating the bearings; the gears carry it to the top of the box, and it passes into the various oil chambers which have openings at the bottom, allowing it to drain back after encircling the shafts, and thus keeping a constant flow of oil on all the revolving parts and reducing the wear and noise to a minimum. The beds are made of extra length, so that there is very little overhang of the table when planing at full stroke. The V's are also made much wider than usual. The tables are made deeper, and have a set of dogs and a complete shifting mechanism on each side. The housings are carried down to the floor, and in addition to the usual bolts and dowel pins are secured to the bed by a long tongue and groove.

The cross rail has a very large bearing on the housings, and is strengthened by an arch-shaped brace at the back. The heads are of a new shape, the end of the tool block and slide being made round to avoid projecting corners on angular work. They are provided with taper gibs and the slides are hung on ball bearings. An automatic tool lifting device is also furnished, which is not shown in the photographs. The side heads are controlled by handles which travel up and down with them, and are, therefore, always convenient to the operator. These side heads are similar to those used on the cross rail, are very rigid, and may be run below the level of the top of the table when not in use. The cross rail is raised and lowered by means of the patent power lifting device, which was described in detail on page 194 of our May, 1904, issue. The driving pulleys have been increased in width, and are furnished with oil reservoirs, which insure their being properly oiled with a minimum amount of attention. The pulley shaft, which is the only high-speed shaft in the machine, is made ring oiling and has Lumen bronze bearings. These machines were made by the Cincinnati Planer Company, Cincinnati, Ohio.



CINCINNATI NEW MOTOR-DRIVEN FORGE PLANER.

IMPROVED MACHINERY IN RAILWAY REPAIR SHOPS.—The great disparity between different shops, both in the time and the cost required to make locomotive repairs is being brought to the attention of financial men in railway management and the opposition to appropriations for shop improvement, has been materially lessened, now that great savings have been demonstrated by many of our up-to-date shops. There is no reason why the repair shops of the railways of the United States, having a yearly payroll of more than one and one-half million dollars, or greater than any other single metal working business in the country, should not be put on a manufacturing basis and provided with modern machinery.—*Progress Reporter.*

PREMIUM PLAN FOR SHOPMEN.—Mr. W. E. Symons, speaking before the Western Railway Club, said that, largely due to the introduction of a premium plan in the shops, the output of a boring mill, which for ten years had never bored to exceed 20 wheels per day, was increased to 60 and 70, and frequently 80 wheels per day. He said: "Improved machinery, of course, must be installed for various kinds of operations, and without that no shop can compete with the better equipped shops that are so provided. But unless the management in charge of the shops has control of its men, receiving their loyal support and best effort, it makes no difference what kind of machines you install, you will never get good results."

BLACKSMITHS' ASSOCIATION.—The National Railroad Blacksmiths' Association will hold its next convention at the Forest City House, Cleveland, Ohio, August 15 to 17, inclusive.

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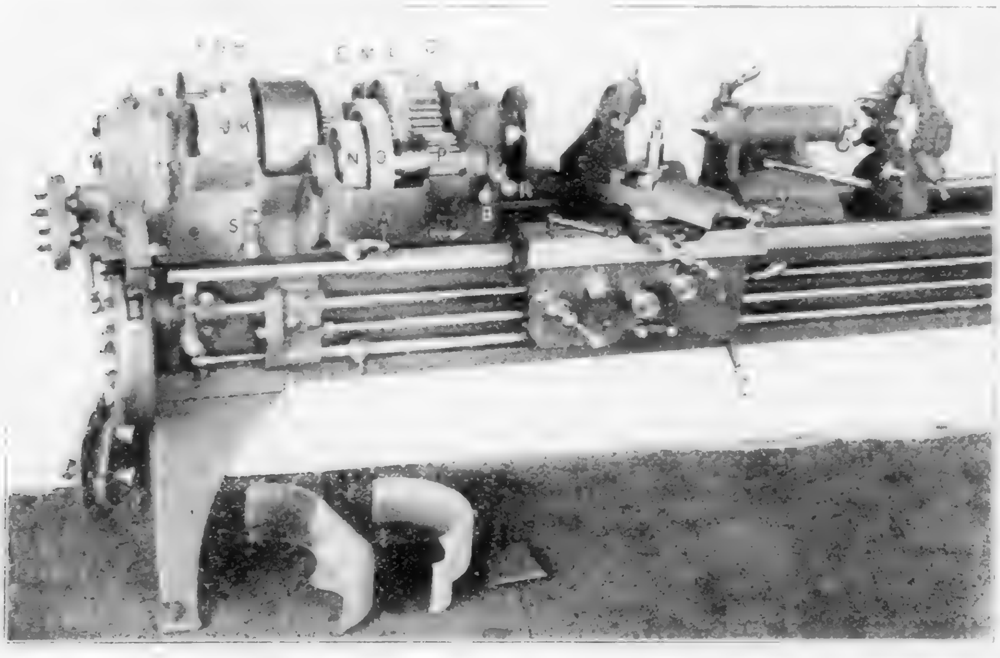

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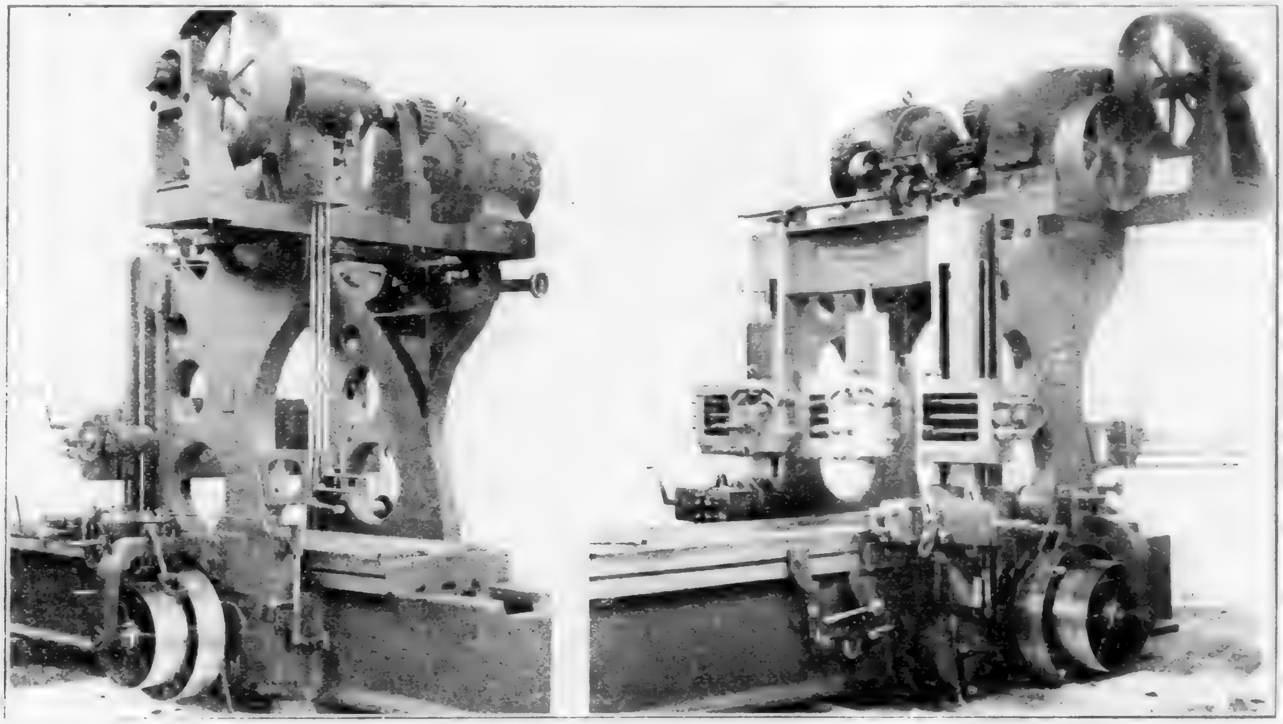


CINCINNATI NEW MOTOR-DRIVEN FORGE PLANER.

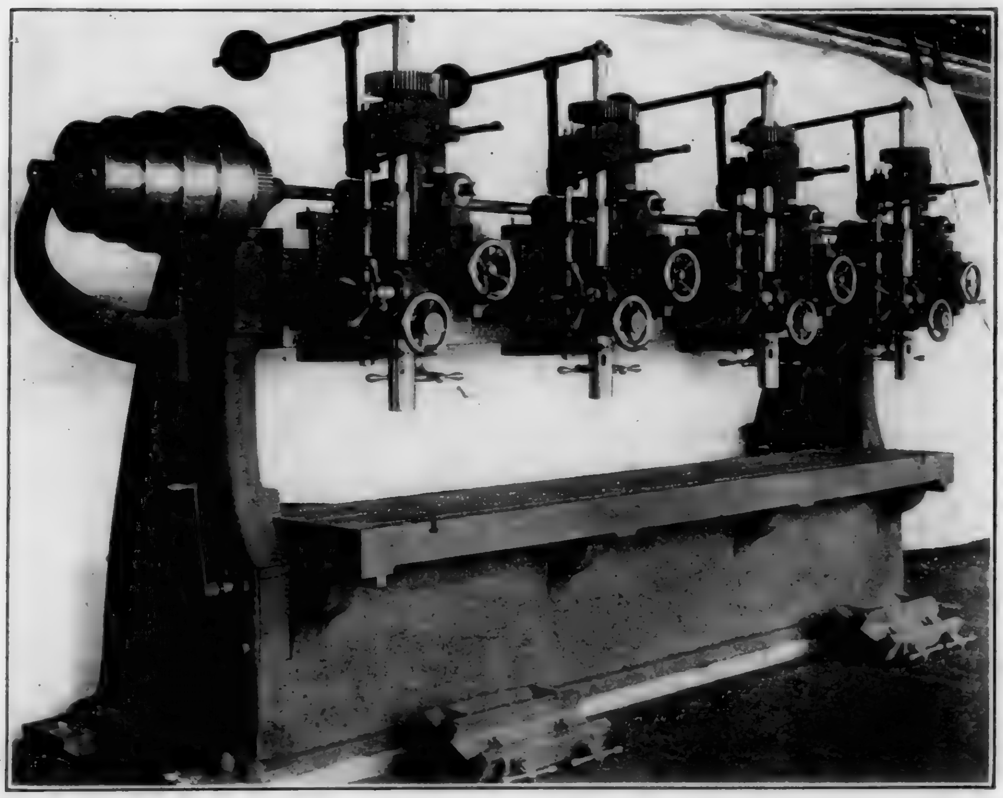
IMPROVED MACHINERY IN RAILWAY REPAIR SHOPS.—The great disparity between different shops, both in the time and the cost required to make locomotive repairs is being brought to the attention of financial men in railway management and the opposition to appropriations for shop improvement, has been materially lessened, now that great savings have been demonstrated by many of our up-to-date shops. There is no reason why the repair shops of the railways of the United States, having a yearly payroll of more than one and one-half million dollars, or greater than any other single metal working business in the country, should not be put on a manufacturing basis and provided with modern machinery.—*Progress Reporter.*

PREMIUM PLAN FOR SHOPMEN.—Mr. W. E. Symons, speaking before the Western Railway Club, said that, largely due to the introduction of a premium plan in the shops, the output of a boring mill, which for ten years had never bored to exceed 20 wheels per day, was increased to 60 and 70, and frequently 80 wheels per day. He said: "Improved machinery, of course, must be installed for various kinds of operations, and without that no shop can compete with the better equipped shops that are so provided. But unless the management in charge of the shops has control of its men, receiving their loyal support and best effort, it makes no difference what kind of machines you install, you will never get good results."

BLACKSMITHS' ASSOCIATION.—The National Railroad Blacksmiths' Association will hold its next convention at the Forest City House, Cleveland, Ohio, August 15 to 17, inclusive.

MULTIPLE DRILL WITH COMPOUND ADJUSTABLE HEADS.

The machine shown in the accompanying illustrations was made specially for the Omaha shops of the Union Pacific Railroad, and was designed to meet the demand for a flue sheet drill which is absolutely independent in all motions to the spindles. The spindles may be set out of line as much as five inches from each other, and it is thus possible to drill a staggered layout of holes within this limit without moving the table. The machine will take a sheet 12 ft. 4 ins. wide between its housings, and the table is provided with 24 ins. of cross adjustment. The chucks shown in the foreground of Fig. 1 are for holding mud rings; the front side of the base of the machine is 8 ins. back of the center line of the spindles, so that when drilling mud rings they can extend down from the chucks into a pit in front of the machine.



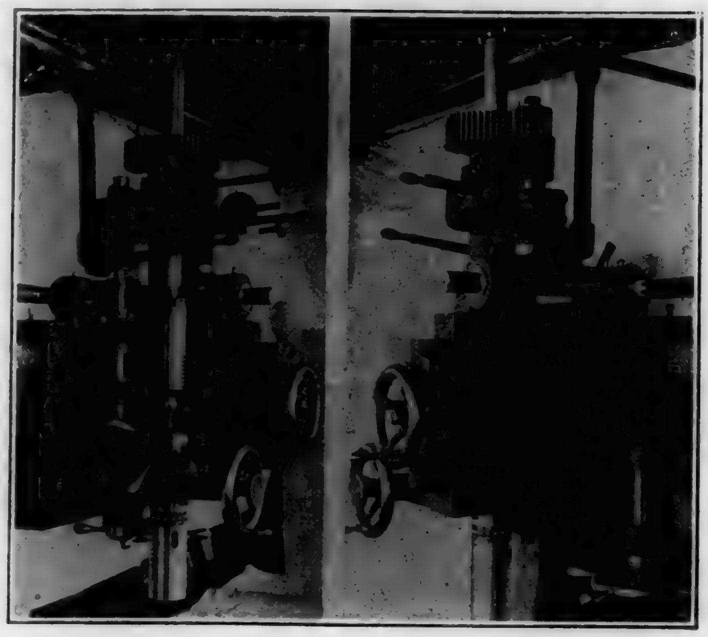
MULTIPLE DRILL WITH COMPOUND ADJUSTABLE HEADS.

Each head is absolutely independent in all its motions, and each spindle may instantly be started or stopped by means of a clutch which is operated by a lever. The feeds are so designed that a change from the feed required for drilling to that for reaming may instantly be obtained by pulling a lever. As the feeds are positive, a safety clutch is provided, so that the feed will slip, if due to carelessness on the part of the operator, the nose of the spindle should strike the work. The heads are adjustable on the cross rail by the hand wheel which operates through the worm and spur gearing. An automatic knock-off permits the feed to be thrown out at any point. The spindle is provided with a quick return motion and also with a hand feed through worm gearing. The spindles are of forged open hearth steel, with ball bearing thrust collars, and have 12 ins. of vertical power feed. The heads are carefully designed for rigidity when the spindles are in the extreme outer position and working under the most severe conditions. Each one of the heads weighs 965 lbs., and this will serve to give some idea as to their strength and size. This machine was made by Foote, Burt & Company, Cleveland, Ohio, and weighs complete about 12 tons.

MAIL SERVICE.—The United States Post Office Department handled last year 9,502,459,535 pieces of mail matter.

AMOUNT OF AIR REQUIRED FOR VENTILATION.

Under the general conditions of outdoor air, namely, 70 deg. temperature and 70 per cent. of complete saturation, an average adult man, when sitting at rest in an audience, makes 16 respirations per minute of 30 cu. ins. each, or 480 cu. ins. per minute. With 70 deg. temperature and 70 per cent. humidity, the air thus inhaled will consist of about one-fifth oxygen and four-fifths nitrogen, together with about 1 7-10 per cent. of aqueous vapor and 4-100 of 1 per cent. of carbonic acid. By the process of respiration the air will, when exhaled, be found to have lost about one-fifth of its oxygen by the formation of carbonic acid, which will have increased about one hundred-fold, thus forming about 4 per cent., while the water vapor will form about 5 per cent. of the volume. In addition, the exhaled air will have warmed from 70 deg. to 90 deg., and, notwithstanding the increased proportion of carbonic acid—which is about one and one-half times heavier than air—will, owing to the increase of temperature and the levity of the water vapor, be about 3 per cent. lighter than when inhaled. Thus it will be seen that this vitiated air will not fall to the ground, as has often been presumed, but will naturally rise above the level of the breathing line, and the carbonic acid will immediately diffuse itself into the surrounding air. In addition to the carbonic acid exhaled in the process of respiration, a small amount is given off by the skin. Furthermore, 1½ to 2½ lbs. of water are evaporated daily from the surface of the skin of a person in still life. If the air supply at 70 deg. is assumed to have a humidity of 70 per cent. and to be saturated when it leaves the body at a higher temperature, then at least 4 cu. ft. of air per minute will be required to carry away this vapor.



DETAILS OF HEADS OF MULTIPLE DRILL.

Taking into consideration these various factors, it becomes evident that at least 4½ cu. ft. of fresh air will be required per minute for respiration, and for the absorption of moisture and dilution of carbonic acid gas from the skin. This, however, is only on the assumption that any given quantity of air, having fulfilled its office, is immediately removed without contamination of the surrounding atmosphere; but this condition is impossible, for the spent air from the lungs, containing about 400 parts of carbonic acid gas in 10,000, is immediately diffused in the atmosphere. The carbonic acid does not fall to the floor as a separate gas, but is intimately mixed with the air, and equally distributed throughout the apartment.

It must then be evident that ventilation is in effect but the process of dilution, and that when the vitiation to be maintained in the apartments is decided, the necessary constant supply of fresh air to maintain this standard may be very easily determined. For the purpose of calculation, 0.6 cu. ft. per hour is accepted as the average production of carbonic acid by an adult at rest, and the proportion of this gas in the external air is as 4 parts in 10,000. If, therefore, the degree of vitiation of the occupied room be maintained, say, at 0.6 parts in 10,000, there will be permissible an increment of only 2 parts in 10,000 above that of the normal atmosphere, or 2 divided by 10,000 equals .0002 of a cu. ft. of carbonic acid in each cu. ft. of air. The 0.6 cu. ft. of carbonic acid produced per hour by a single individual will, therefore, require for its dilution to this degree 0.6 divided by .0002, equals 3,000 cu. ft. of air per hour. Upon this basis the following table has been calculated:

Cu. ft. of Air Containing 4 Parts of Carbonic Acid in 10,000 Supplied Per Person.

Per Hour.	6,000	4,000	3,000	2,400	2,000	1,800	1,714	1,500	1,200	1,000	525	375	231
Per Minute.	100	66.6	50	40	33.3	30	28.6	25	20	16.6	9.1	6.2	3.8
Degree of Vitiation of the Air in the room. (Parts of carbonic acid in 10,000.)	5	5.5	6	6.5	7	7.33	7.5	8	9	10	15	20	30

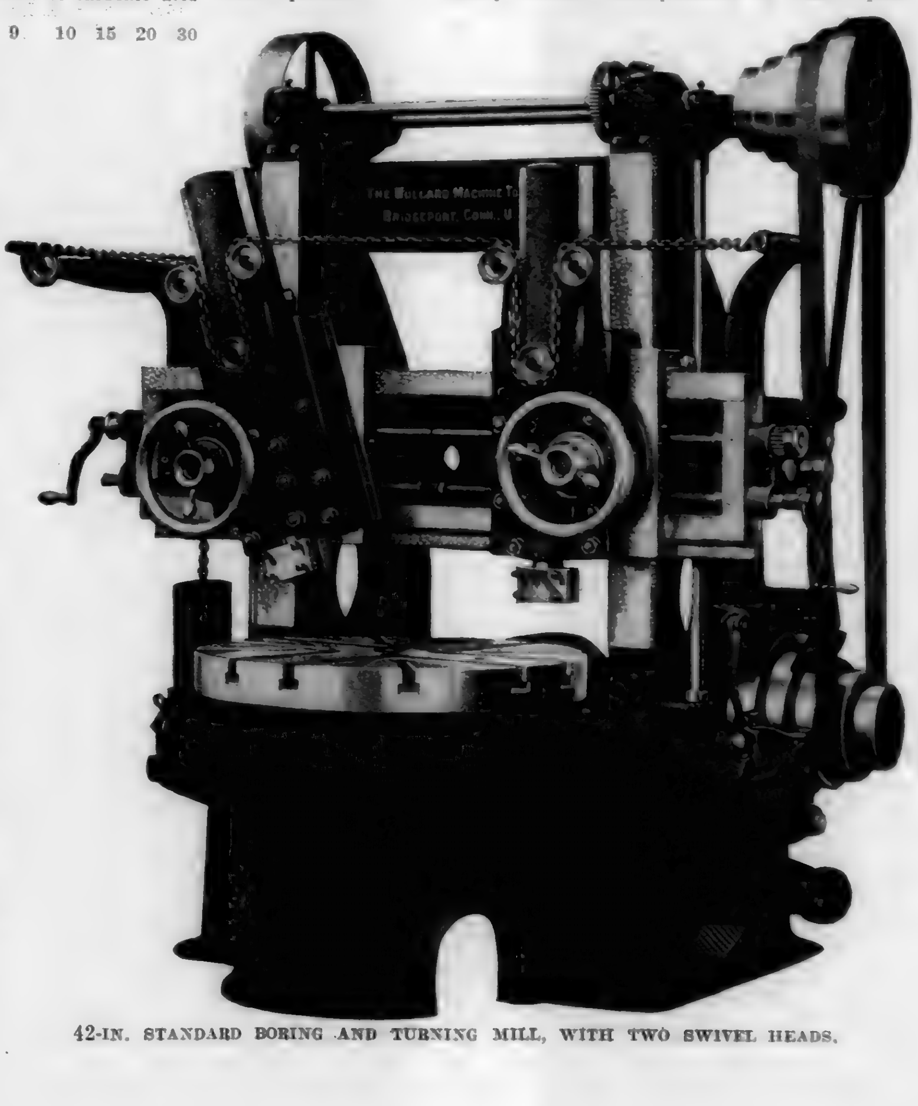
The figures indicate absolute relations under the stated conditions, and are generally applicable to the ventilation of schools, churches, halls of audience and the like, where the occupants are reasonably healthy and remain at rest. But the absolute air volume to be supplied cannot be specified with certainty in advance, without a thorough knowledge of all the conditions and modifying circumstances; in fact, the climate, the construction of the building, the size of the rooms, the number of occupants, their healthfulness and their activity, together with the time during which the rooms are occupied, all have their direct influences. Under all these conditions, it is readily seen that no standard allowance can be made to suit all circumstances, and results will be satisfactory only in so far as the designer understandingly, with the knowledge of the various requirements as they have here been given, makes such allowance.—*Extract from Treatise on Ventilation and Heating, by B. F. Sturtevant Company, Boston, Mass.*

New Tool Steel.—The Sheffield *Daily Independent* states that the Sheffield Steel Makers, Ltd., are putting a new tool steel known as "Unor" on the market, which has a cutting and wearing capacity ranging between Mushett and the best high-speed steel, is easily hardened and can be sold at a very reasonable price.

42-INCH BORING AND TURNING MILL.

The record of one hundred and twenty-two cylinder packing rings in ten hours at the West Albany shops of the New York Central Railroad, which was described on page 235 of our June issue, has excited considerable attention, and a description of the machine upon which this record was made will be of interest. The machine is a Bullard standard 42-in. boring and turning mill, with two swivel heads, and has a capacity in height of 32½ ins. The table is 37½ ins. in diameter, and is driven by bevel gearing at its extreme diameter. Due to a large angular thrust bearing the table spindle has a self-centering tendency, and the weight of the table and spindle and the work upon the table tends to preserve rather than destroy the alignment. The side strains are taken by straight vertical bearings of large proportion. Ten changes of spindle speed ranging in geometrical progression are provided, and a change to any desired speed may instantly be made by a mechanical belt shifter which is built into the machine. The belt cannot twist or run off the cone, and it is automatically locked in position at each step. The table may be stopped instantly at any desired point by a brake which is operated by a lever conveniently placed.

The cross rail is of a heavy box section, is very rigid and is square locked throughout. It is raised and lowered by power independent of the table drive. The heads are entirely independent in their movements, both as to the direction and amount of feed, and either head may be brought to the center for boring, a positive center stop being provided. The tool bars have a vertical movement of 20 ins., and may be set at any angle up to 45 degs., either side or the center. Ten positive feed changes are provided, ranging from 1-32 to ¾ of an inch horizontally, and from 1-50 to ½ in. in vertical and angular directions. The feed works for each head are independent, and, as will be seen, are very conveniently placed for the operator. A safety device incorporated in each speed



42-in. Standard Boring and Turning Mill, with Two Swivel Heads.

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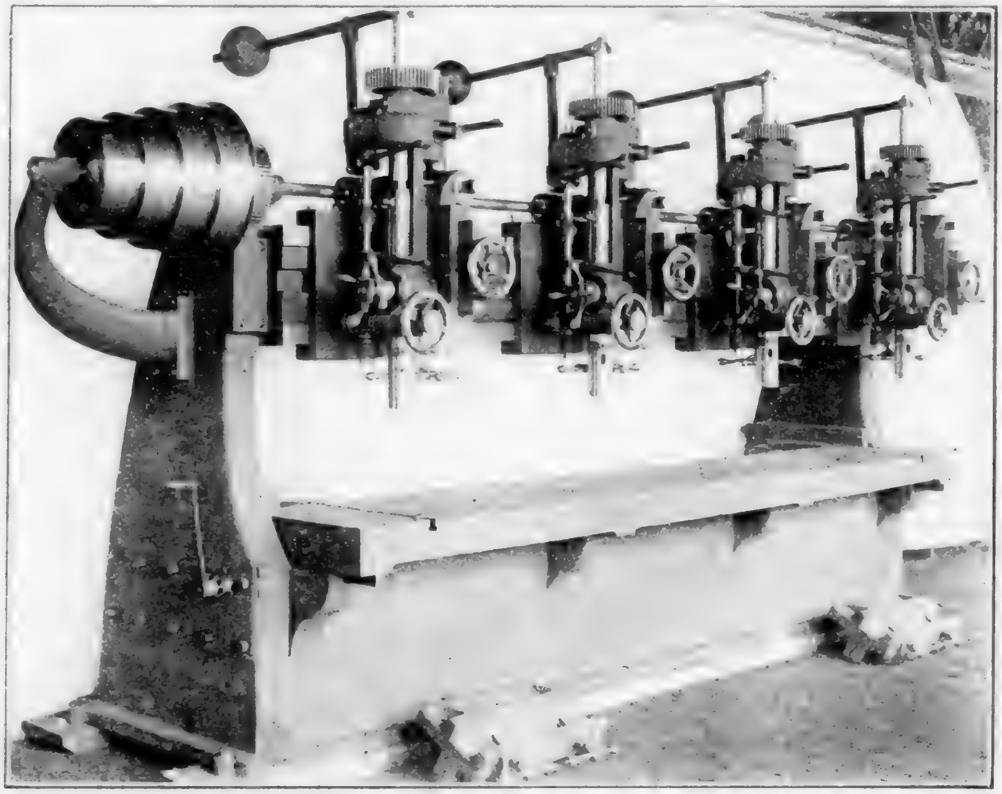

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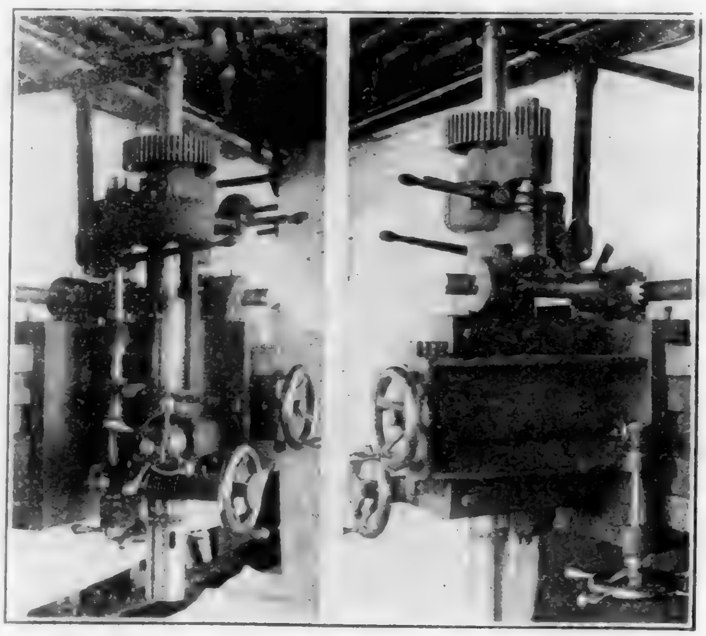

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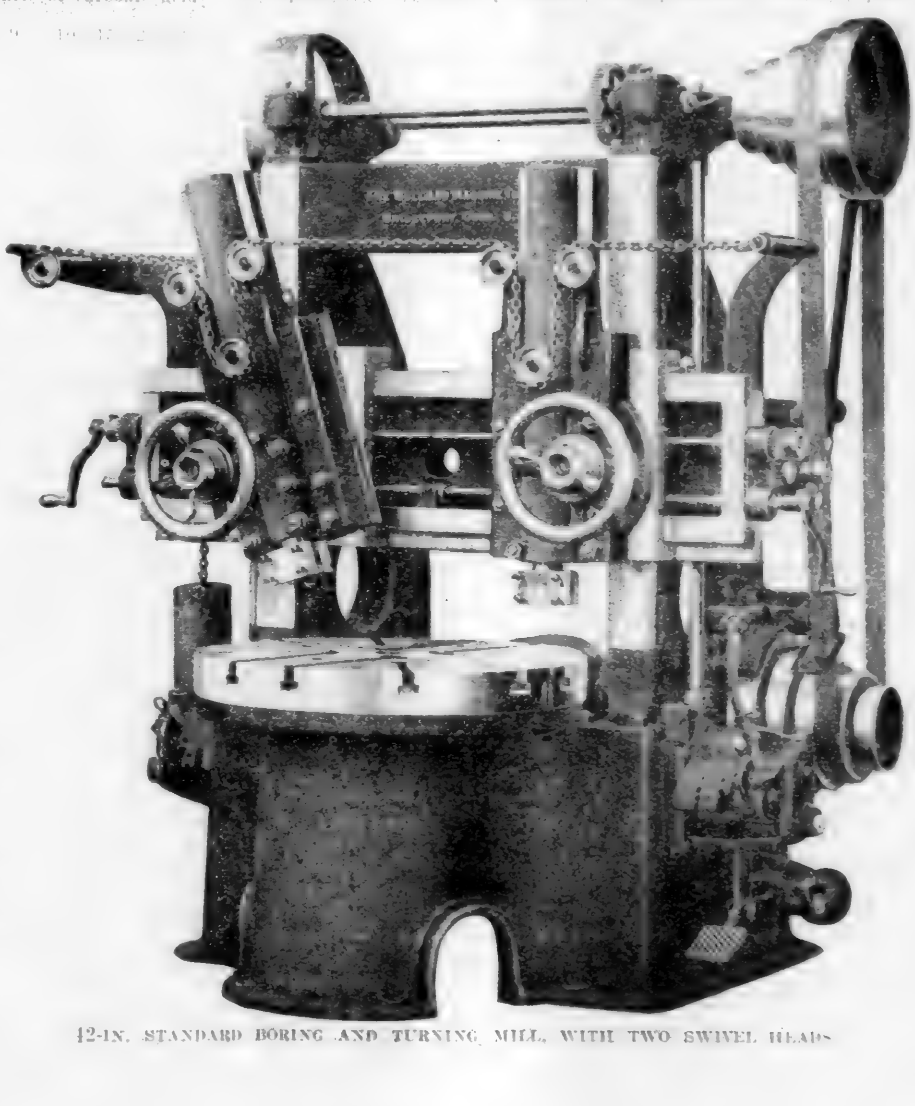


42-IN. STANDARD BORING AND TURNING MILL, WITH TWO SWIVEL HEADS

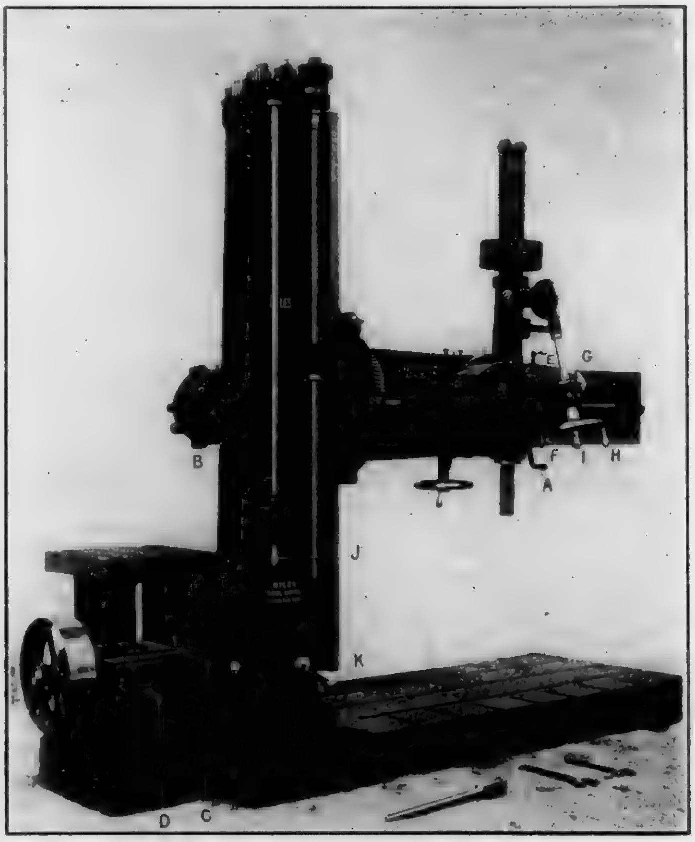
works prevents breakage of the gears or mechanism by careless handling of the heads.

A 5-h.p. constant speed motor may be mounted on a bracket at the side of the machine and connected to the top shaft by either a belt or silent chain, or a 7-h.p. variable speed motor having a speed range of one to four may be direct connected by either gearing or silent chain to the head stock driving shaft, thus doing away with the cones. The net weight of this machine, which is made by the Bullard Machine Tool Company, Bridgeport, Conn., is 11,000 lbs.

SIX-FOOT UNIVERSAL RADIAL DRILLING MACHINE.

The 6-ft. full universal radial drilling machine, illustrated herewith, while designed specially for the use of high speed drills, has a sufficient range of spindle speeds to adapt it for the use of carbon steel drills also. It is the result of the experience of the five works of the Niles-Bement-Pond Company in the design and manufacture of radial drills and is noteworthy because of its ease of manipulation and the fact that all parts which require adjustment by the operator are within easy reach. The drill head saddle fits between, as well as outside of the arm guides, which completes the double box section of the arm and insures rigidity. The column saddle is strongly gibbed to the flat bearing on the column and the post about which the column revolves extends to the extreme top of the sleeve. The column rests on ball bearings. Friction clutches are used for starting and stopping the machine at high speeds in order to prevent shock and the consequent wear. All speeds and feeds may be changed while the machine is running at even the fastest speeds. The speed box is planed on top in order that the machine may easily be changed from a belt to a motor drive by simply replacing the pulley by two gears.

Sixteen speeds and eight feeds are provided. The lever A starts and stops the spindle and reverses it for tapping. Lever B operates the friction back gears. The handle C furnishes two speeds for each position of the tumbler gear handle D. The handle E furnishes a fast or slow feed for each of the four positions of the lever F. The hand wheel G is used in connection with the hand feed hand wheel H and has the double function of operating either the friction or the spindle quick return, depending on the up or down position of the pull-clutch I. The handle J controls the raising or lowering of the arm at a speed of from 20 to 70 ins. per minute. The wrench K clamps the sleeve to the post. The maximum distance from the face of the column to the center of the drill is 77½ ins; the least distance from the face of the column to the center of the drill is 22½ ins.; the greatest distance from the spindle to the base plate is 72 inches and the spindle has 20 ins. of traverse.

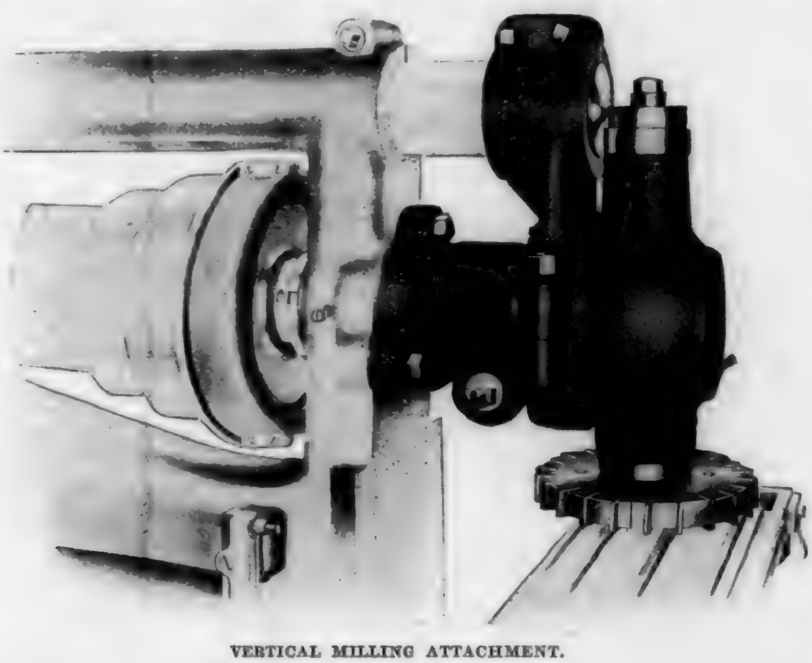


UNIVERSAL RADIAL DRILLING MACHINE.

NEW VERTICAL MILLING ATTACHMENT.

A powerful but very compact and simple vertical milling attachment for use on horizontal milling machines has just been brought out by the Kempsmith Manufacturing Company, Milwaukee, Wis. It has been designed to handle a very heavy class of vertical milling, and is capable of doing as heavy work as the strength of the main spindle itself will stand. The bevel gears in the head are of steel, case hardened, and have large faces and coarse pitch. In order to maintain a perfect alignment the vertical spindle has very long bearings, and provision is made for a delicate adjustment for wear. The head is graduated and may be swiveled to any angle. Its construction is such that only two bolts are required for adjusting and securely clamping it, and both of these bolts are very conveniently located for the operator.

The horizontal bolt which clamps the head in the bracket is of the friction type and has very great clamping power. The vertical spindle has a taper hole, and is threaded for the large face milling cutters; both the taper hole and the thread are the same as those on the main spindle, thus making all tools interchangeable. Draw bolts are furnished for drawing in and backing out of end mills. As will be seen from the illustration, the design of the head is such that the distance from the center of the horizontal spindle to the nose of the vertical spindle is very short, so as to allow as much space as possible between the table and the vertical mill. This attachment is built in three sizes, which are drilled to the same jigs as the columns of the machines for which they are intended, so that they may be applied to any Kempsmith miller of certain sizes now in use.


VERTICAL MILLING ATTACHMENT.

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Shop Layouts.

Committee—C. A. Seley, R. P. C. Sanderson.

Few roads are so situated that one shop could take care of all their heavy repairs even if that were desirable, which we believe not. We do not at this time wish to take a stand for or against the large shop, meaning the extreme size possible. That question must be determined by the road or system for itself, viewing the question from the standpoint of road layout, organization, labor facilities, etc. The very large shop presents an opportunity for tying up the road by fire, strikes or accident that is not present when several smaller shops are used. On the other hand, it is hardly feasible to provide the smaller shops with all of the facilities and refinements now thought essential in the equipment of the large shop, and by these we mean not only the machine tools and handling appliances, but the multitude of small tools and appurtenances not generally reckoned or appreciated. Many roads lack in proper repair facilities at terminals and division points where the stitch in time saves many an engine failure. No matter how large and complete the main shop may be, the outlying points can advantageously and profitably use a moderate tool equipment for taking care of running and light accidental repairs, leaving heavy repairs and manufacturing to be done at the main shops. With such an equipment and organization, we believe that relatively small shops are undesirable, expensive and unprofitable, and that the larger, completely equipped main shops will handle the repairs in the most satisfactory manner.

The railroads represented in this association have all kinds of shops, many of them capable of improvement, and in the last few years there has been a number of large shops built, no two on the same general plan, yet embodying more or less of the strictly modern lines of improvement in buildings, equipment and facilities. Railroad managements, owing perhaps to traditional conservatism, have not been quick to grasp the improvements in shop processes and equipment that are deemed essentials in other lines of business. It is true that railroads are not manufacturers, as a rule; but if the repairs of locomotives and cars involve the same processes to a great extent as in their manufacture, either the manufacturers of railway equipment and machinery are unduly extravagant in providing roomy, well-lighted buildings, traveling cranes and hoists, electric transmission of power and lighting, special tools of latest designs, all tending to labor saving or putting the workmen on a better plane, or else the railroads are neglecting their opportunities and daily paying for it in the increased cost of their repairs.

Most of us, doubtless, have visited many shops where locomotives, cars and heavy machinery are built, and we could not help contrasting the methods of the successful manufacturers with those of the average railroad shop. If we analyze the matter and seek the reasons governing the situation on railroads, we find, first of all, that the average shop is planned and equipped for handling the average locomotive of say 10 or 15 years ago and with machinery, much of it, of a greater age. During that period we have increased steam pressure 25 per cent., increased tractive power 50 per cent., increased total weight 75 per cent. and tank capacities of 7,000 and 8,000 gals. are now common, an increase of nearly 100 per cent.

The demands of our managements for high speed and heavier tonnage to meet competition have brought about the development of machines for hauling trains that put the crack engines of a few years ago on the branch lines and on second-class trains or in the market for sale, to make way for heavier power. Wheels under the engines have been multiplied and so have cylinders. Rods are now so heavy that it takes a gang of men to handle them. Everything about the engines is on a larger scale, but how about the shops?

It is quite plain to our managements that it takes twice as long to water an engine with the 6-in. standpipes that were good enough in the old days and they see the necessity for enlarging on that line to cut down time.

Is it not equally important to supply facilities for handling the locomotive parts that have perhaps doubled in weight since the old shops were built? It used to be considered good enough to jack up an engine or, perhaps, to have a drop table for wheeling, and we are still doing too much of it, a practice that would be ridiculed by any live business man whose profits depended on modern methods of handling.

Now, whose fault is it that so many railroad shops are behind the times? It may be the fault of the management in not approving the recommendations of live motive power officers, who are awake to the situation and see their maintenance expense rising and are unable to check it on account of lack of facilities. The heavy modern engines do not stay out like the old timers and shoppings are more frequent, demanding greater shop facilities for a given number of engines than was necessary when engines were lighter, trains were shorter and time was longer. Some roads may think they are too poor to make these expenditures, and, of course, they should have our sympathy if this were true, but it is not.

Based on the principle that a manufacturing business will be most profitable when conducted with a plant, equipped with modern appliances, labor-saving devices for economical production, well organized and rationally directed; a railroad shop to be most efficient should be equally well equipped, organized and directed.

It is stated, however, in some quarters, that although the argument may be good, it has not been proven by the results obtained at the large modern shops, and that many old shops are yet more efficient that the new. It must be admitted that there is much of truth in this, but for reasons which, perhaps, can be explained and the difficulties to some extent can be overcome.

Some shops have been built in which the money has been expended for ground and buildings and then these are filled with back-number machinery. In this case, aside from improved facilities for handling, no gain in the cost of the machine work is accomplished. A road with such a shop will need to make purchases of extra motive power in order to do business. When buying engines, if they would cut off one or two and expend their value in tools, the balance of the power could then be brought up so that the extra engines cut off would not be needed. It is not a question of how many engines a road has, but how many good, serviceable engines, and this depends on the facilities for repairing and keeping engines running. In this connection it is suggested that a system of cost keeping for manufactured work and various operations will shed much light on the comparative value of old and new machinery. The development in tool improvement and the use of high-speed steels has made large economies possible, the exact amount of which can only be determined by an accurate cost keeping system, which can very profitably be carried out in the larger shops.

Another shop, equally well located and built, is equipped with a large line of modern tools, new from the makers. The shop is started and the management expects immediate results and they are not forthcoming. Why? Because the shop lacks that important equipment of the old shop in small tools, cutters, mills, jigs, formers, templates, bars, blocking, clamps and handy appliances that the old shop has been years in accumulating. The new shop will be handicapped for lack of these for some time, as they are an unappreciated asset in the business of the old shop.

Other well-equipped shops have been built at new points where the management deemed wise to locate, but almost invariably this has been the cause of long delay in getting together an organization to work the shop up to its capacity.

Railroad shop work cannot be successfully performed by the floating element. A large proportion of the force must be permanent, settled in homes, convenient to schools and churches and other advantages and have something to live for beyond the empty honor of being an employe of the great North, East, South and West Railway.

No matter how well built and equipped the shop may be, its efficiency will be measured to a great extent by the class of men that can be obtained to work it. Unless the railroads are wise enough to see to it that they must, to a certain extent, bring the shops to the men, they will fail in getting the best material.

In order to get and hold the proper class of men, shop work should be fairly constant. Frequently the motive power department is embarrassed by the difficulty in getting appropriations for maintaining force and organization at times when business is slack. When business is good, engines are worth from \$25 to \$50 per day, or perhaps more, and every day in the shop or out of service is that much loss. When business is dull and the full locomotive equipment is not needed, the engines needing repair could then be put through the shops and laid up ready for the return of business. By thus keeping engines up a less number is needed, investment being devoted to maintenance, instead of multiplication. There is no doubt of the results of having a uniformly good standard of equipment, as against a lot of cripples, helped out with occasional new engines, often of new design, requiring time and considerable expense in getting patterns and repair parts.

The matter of recruiting for shop forces is one that is assuming considerable importance. We are not now making the all-around mechanics, which most of us were some years ago, equally at home on the machines, the bench or on the floor. The apprentice question is a vital one, deserving the attention of not only the motive power officers, but the higher officials as well. As the older methods seem to be outgrown, new methods of recruiting must be tried, including, possibly, educational courses in connection with the shop work.

The difficulty of getting suitable men for foremen in smith shops and boiler shops is particularly noticeable. The spirit which at present dominates workmen is one apparently not elevating the more worthy or ambitious ones among them, but rather establishing a dead level of mediocrity from which it is difficult to select leading men for foremen and places of responsibility.

Some of this has been brought about by the increasing distance between the officers and the men, due to increase in the size of railroads, in many cases now amounting to many thousand miles and a vast number of men. Formerly a motive power officer knew almost every man on his pay-roll, and this personal contact, although not necessarily amounting to familiarity, nevertheless contributed to a spirit of *esprit de corps* that was invaluable in preserving organization, conserving good feeling and enabling prompt settlement of all questions.

Owing to the inability of the head of the motive power department of a great railroad to frequently visit outlying shops and terminals, this spirit is lost unless it is fostered by subordinate heads. The growth by combinations, etc., of railway systems in the last few years have been so rapid that we have not had the time or opportunity of impressing this feeling on subordinates to the extent that it should be. Furthermore, in these expansions of railroads it is sometimes the case that the jurisdiction of subordinates is increased so as to cover too much territory, or in the case of foremen, they have too many men to handle to the best advantage. With the decreasing individual capacity of workmen, superintendence, supervision and instruction are more necessary than ever.

Suppose we have the big shop. It remains to get the best out of it, despite the possible drawbacks that have been named, and discover a policy, if possible, necessary for the success of these shops and the other big shops that are to come. As the big engines are handicapped by the small water cranes, small roundhouses and other small things, it is a possibility that the big shop is handled in a small way by a small man or, perhaps, by a big enough man, but tied down by small regulations and restrictions that do not permit him to do what could be done if he were more of a free agent. It is not well to give a small man a free hand, as he will make mistakes and is not equal to developing large

things. The successful manufacturers have very competent men at the heads of their departments and they pay them salaries that railroad managements would deem extravagant for men having equal responsibility and the disbursement of, perhaps, greater amounts of pay-roll. The railroads must realize that for superior service, they must meet the salaries paid by the manufacturers. They have lost many a good man, who, while greatly desiring to remain in railway service, could not afford to do so in view of the inducements offered by the manufacturers. The railroads get more of what may be called professional service, not only in the motive power department—work of men who have to fit themselves by long training, by study and earnest effort—for less money than almost any other line of business.

For a successful shop manager, the man must not only have practical and technical knowledge and experience, but must have tact and a knowledge of men and affairs, dignity, yet with all a familiarity that will make the humblest employe feel that he has a friend, yet one that he must respect.

The complicated labor problems of to-day will not be less complex in the future. The proper labor equipment is so vital a factor in the successful operation of shops or business that the small man, or even the large man who has but limited opportunities, may fail in handling that feature in management.

The larger shops also present an opportunity for manufacturing on a very profitable basis the repair parts for storehouse stock and subsequent shipment to outside points.

The extent to which this may be done is almost entirely limited by the machine facilities of the shops, such extra work demanding extra machinery. The output of the shops in engines should not be affected one way or the other by the manufacturing, which should be separately accounted for and properly credited. Many large shops do a great deal of work outside of the requirements for repairs of engines which they actually have on hand, and this, together with work for the other departments, such as bridge jobs, maintenance of pumping machinery, etc., form a very large portion of the output of many shops.

Manufacturing methods can also be extended to cover many of the regular shop operations, and by doing so this work can be reduced to a business basis, done on business methods.

Regarding the presentation of standard shop layouts, your committee has decided that it is best not to recommend any certain types, but to reproduce the articles on that subject contributed recently to the American Engineer and Railroad Journal by Mr. R. H. Soule, originally chairman of this committee. Mr. Soule was obliged to resign from the committee on account of the loss of health, and we regret losing the benefit of his assistance and advice in the preparation of this report.

The articles give the latest complete descriptions and analysis of the important railroad shops of this country and include data covering smith shops, car shops, stores, roundhouses, etc., but for the purposes of this report only those portions relating to erecting, machine and boiler shops are included, and these have been revised sufficiently to bring them up to date by including all data possible to obtain relative to the latest shops built.

The original articles by Mr. Soule were published in the American Engineer and Railroad Journal in February, March, April, May, June, October, November, December, 1903, and in January, February, March, April, May, June and July, 1904.

Locomotive Front Ends.

Committee—H. H. Vaughan, F. H. Clark, Robert Quayle, A. W. Gibbs, W. F. M. Goss.

Your Committee on Locomotive Front Ends begs to state that at the last convention of this association a motion was carried authorizing the Executive Committee to appropriate, at its discretion, such funds as were necessary to carry out the series of experiments outlined in the report of this committee which was then presented, when money for such work should be available. It was then supposed that it would be necessary to await the receipt of funds raised by the subscription then contemplated for representative membership, but at a meeting of the Executive Committee held subsequent to the convention the secretary was instructed to issue a circular letter to the various railroad companies and locomotive builders in the United States, asking for subscriptions to enable the American Engineer tests on locomotive front ends to be carried out to a conclusion. The responses to this letter were generous and immediate, and a total amount of $3,035 was contributed by the following railroad companies and locomotive builders:

American Locomotive Co.	$ 215.00
Ann Arbor R. R.	10.00
Baldwin Locomotive Works	215.00
Buffalo, Rochester & Pittsburgh Ry	20.00
Bessemer & Lake Erie R. R.	10.00
Canadian Northern Ry	10.00
Chicago & Western Indiana R. R.	10.00
Chicago, Lake Shore & Eastern Ry	5.00
Colorado Midland Ry	10.00
Canadian Pacific Ry	90.00
Cincinnati, Hamilton & Dayton Ry	10.00
C. H. Cory	10.00
Chicago, Burlington & Quincy Ry. (West)	40.00
Chicago, Burlington & Quincy Ry. (East)	80.00
Chicago & North-Western Ry	130.00
Chicago & Eastern Illinois R. R.	20.00
Cincinnati Northern Ry	10.00
Cincinnati, New Orleans & Texas Pacific Ry	10.00
Central New England Ry	10.00
Chicago, Indianapolis & Louisville Ry	10.00
Cleveland, Cincinnati, Chicago & St. Louis Ry	50.00
Chicago, Milwaukee & St. Paul Ry	100.00
Cumberland Valley R. R.	10.00
Chicago Great Western Ry	30.00
Chicago, Rock Island & Pacific Ry	110.00
Chicago & Alton Ry	20.00
Duluth, Missabe & Northern Ry	10.00
Delaware, Lackawanna & Western Ry	60.00
Duluth, South Shore & Atlantic Ry	10.00
Duluth & Iron Range Railroad	10.00
Delaware & Hudson Co.	30.00
Elgin, Joliet & Eastern Ry	5.00
Erie Railroad	25.00
Grand Rapids & Indiana R. R.	10.00
Great Northern Ry	70.00
Galveston, Harrisburg & San Antonio Ry	30.00
Illinois Central Railroad	110.00
International & Great Northern Ry	10.00
Intercolonial Railway	20.00
Kansas City Southern Ry	10.00
Long Island Railroad	25.00
Lake Shore & Michigan Southern Ry	50.00
Louisville & Nashville R. R.	50.00
Michigan Central R. R.	40.00
Maine Central R. R.	10.00
Minneapolis, St. Paul & Sault Ste. Marie Ry	10.00
Mobile & Ohio R. R.	10.00
New York, New Haven & Hartford R. R.	25.00
New York, Ontario & Western Ry	10.00
New York, Chicago & St. Louis R. R.	10.00
Nashville, Chattanooga & St. Louis R. R	20.00
Norfolk & Western Ry	60.00
Northern Pacific Ry	90.00
Oregon Short Line	10.00
Oregon Railroad & Navigation Co.	10.00
Pennsylvania Railroad	300.00
Penna. Lines West	120.00
Pittsburgh & Lake Erie R. R	10.00
Pere Marquette R. R.	30.00
Richmond, Fredericksburg & Potomac Ry	10.00
Southern Ry.	110.00
St. Louis & San Francisco R. R.	70.00
San Pedro, Los Angelos & Salt Lake R. R.	10.00
Seaboard Air Line Ry	30.00
Southern Indiana Ry	10.00
San Antonio & Aransas Pass Ry	10.00
Southern Pacific Company	90.00
Texas & Pacific Ry	30.00
Toronto, Hamilton & Buffalo Ry	10.00
Terre Haute & Indianapolis R. R.	10.00
Union Pacific R. R.	50.00
Virginia & South-Western Ry	10.00
Wisconsin Central Ry	10.00
Western Ry. of Alabama	10.00
Wheeling & Lake Erie Ry	10.00
Wabash R. R.	40.00
Total	$3,065.00

Your committee was thus furnished with the necessary funds to carry out the work assigned to it, but unfortunately the testing plant at Purdue University was then occupied with other experiments, and could not be released for the purpose of carrying out the tests on locomotive front ends. These experiments have not yet been concluded, but we are pleased to advise that arrangements have been made whereby the New York Central has kindly offered to loan us a locomotive by October 15 of the present year, at which time Purdue University will make arrangements to receive it. The tests that it is proposed to make have been modified somewhat from the outline given in 1904 report, and your committee begs to present the following scheme of experiments for the criticisms of this association, which will, of course, be carried out on a New York Central engine having large front end diameter, which will decide the relations between large and small front ends:

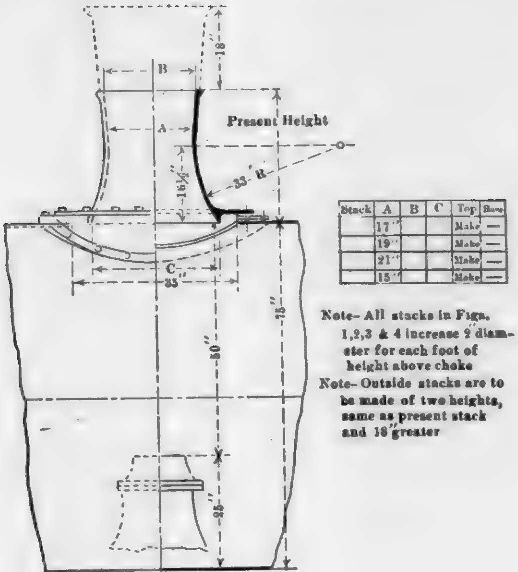
1. Diameter of Stack.—It is proposed to conduct tests involving four different diameters and two different heights of outside stacks of dimensions set forth by Sketch 1, the lower stack to have a height normal to the engine, the higher to have a height 18 ins. greater than this. The diameters to be 15, 17, 19 and 21 ins., respectively. It is expected that data thus derived from a boiler of large diameter will serve in checking formulæ based upon results obtained from the small boiler of the Purdue locomotive, or in case they do not check, it will serve in the establishment of new formulæ. All stacks, of whatever diameter or height, are similar in form. The curvature of the base is the same for all, and the distance from the lower end to the point of greatest contraction is the same. Above the point of greatest contraction all have a uniform taper of 2 ins. to the foot.

2. Inside Stacks.—To determine the value of the inside stack, it is proposed to employ four different diameters and three different lengths, all to be used in connection with an outside stack of height normal to the engine. The proposed stacks are shown by Sketches 2, 3 and 4. As in the case of the outside stacks, the inside stacks are similar in form, all being the same in the curvature of their base, the distance from the point of greatest contraction to base, and in the degree of taper of the upper portion of the stack.

3. False Tops.—For the purpose of determining the effect of blanking off the top of the smokebox, it is proposed to construct a false top, which may be used in connection with stacks having 12 and 24-in. inside projection (Sketches 2 and 3). Each top will have in the center a circular opening reinforced by an angle iron (L), this opening to be sufficiently large to admit stacks of the largest diameter. To make connection with the stacks of different diameters, filling rings will be employed, made up of two angles and a sheet-iron plate, as shown at M. N, Sketch 7.

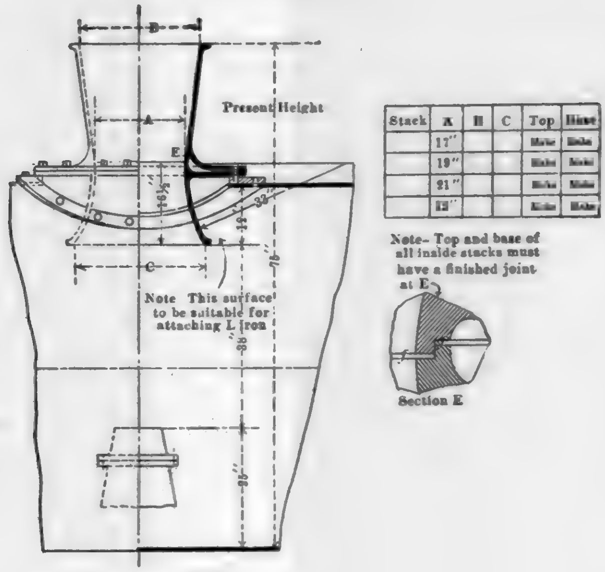
4. Draft Pipes.—It is proposed to employ single-draft pipes having diameters 13, 15 and 17 ins. and lengths from 18 ins. to 48 ins., lengths to increase by 6-in. increments. Each increment is secured by adding a new section, as shown by Sketch 6.

Experiments upon double-draft pipes will be made to involve the apparatus already outlined. To give facility in adjusting the draft pipes, it is proposed to have them so mounted that they may be raised or lowered by means of levers extending outside of the smokebox. The details of this arrangement are suggested by Sketches 5 and 6. By reference to these figures, it will be seen that two columns (*a a*), having their support in an extension upon the exhaust pipe, are provided as guides for the draft pipes. The draft pipe *b* slides freely on these columns, being applied thereto by some form of fitting which will admit of easy adjustment.



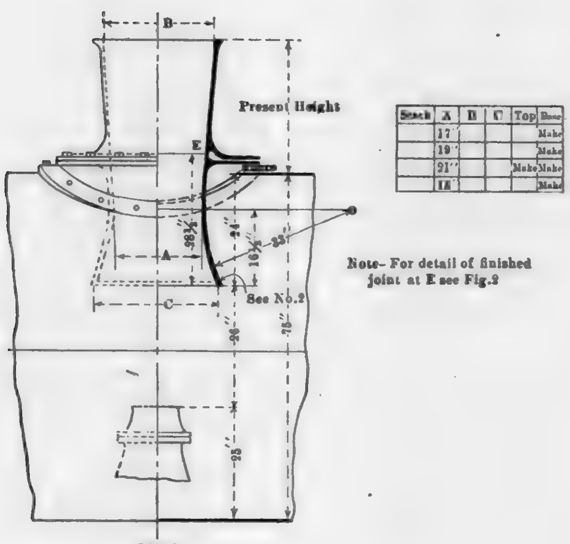
Stack	A	B	C	Top	Base
	17"			Make	—
	19"			Make	—
	21"			Make	—
	15"			Make	—

Fig. 1



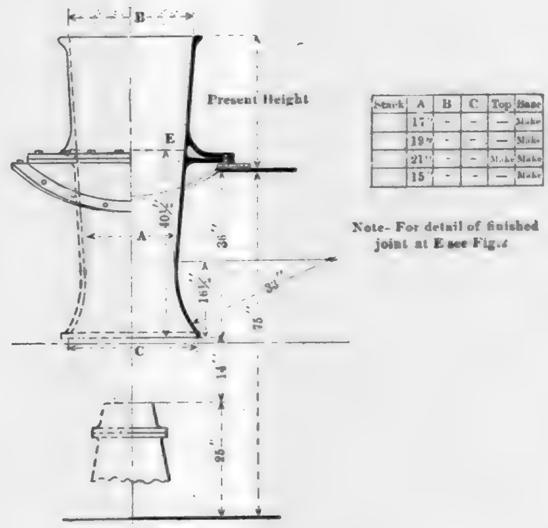
Stack	A	B	C	Top	Base
	17"			Make	Make
	19"			Make	Make
	21"			Make	Make
	15"			Make	Make

Fig. 2



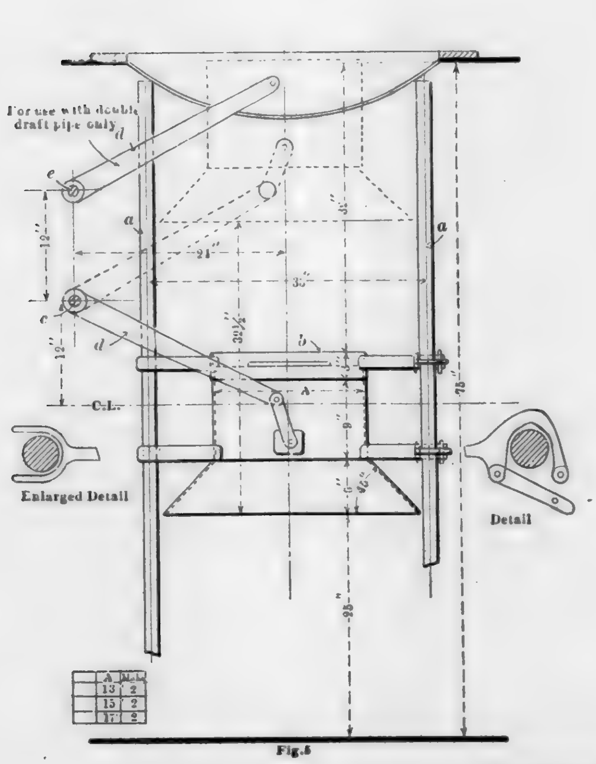
Stack	A	B	C	Top	Base
	17"				Make
	19"				Make
	21"			Make	Make
	15"				Make

Fig. 3



Stack	A	B	C	Top	Base
	17"	-	-	—	Make
	19"	-	-	—	Make
	21"	-	-	Make	Make
	15"	-	-	—	Make

Fig. 4



	A	Make
	13	2
	15	2
	17	2

Fig. 5

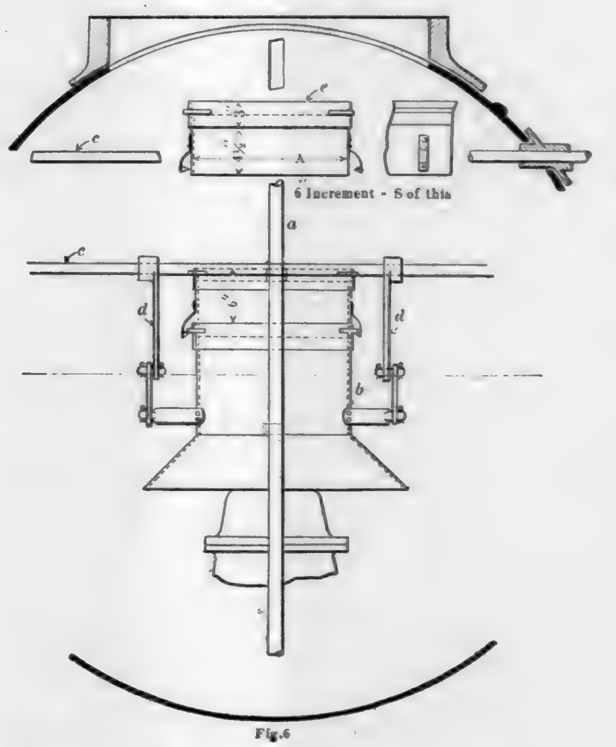


Fig. 6

LOCOMOTIVE FRONT END TESTS.

The vertical position of the draft pipe *b* is controlled by its connection with the lever arm *d* and the shaft *c*. The latter is supported by bearings attached to the smokebox shell, and extends out through the shell a sufficient distance to receive a counterweight and operating lever not shown in the drawings. By having the operating lever pass over a graduated scale, it is thought that it will be possible to place the draft pipes in definite positions without the necessity of opening the front door.

It will be seen that your committee is not carrying out the instructions under which it was appointed, so far as experimenting

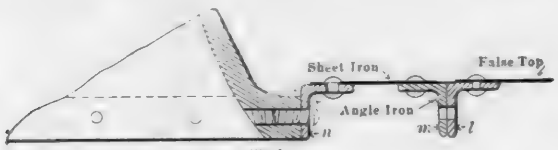


Fig. 7

on the elimination of the diaphragm is concerned; this has been shown by the experiments on the testing plant at St. Louis to be a most important factor in the proportion which the draft utilized in burning coal bears to the total draft produced, but in view of the information that has been obtained on this subject at St. Louis, your committee considers that further experiments on the testing plant would be valueless. Assuming that the first requirement is to obtain a self-cleaning front end, it will require lengthy and practical experimenting to ascertain what design will afford the self-cleaning feature with the least obstruction to the passage of the front end gases, and your committee feels that this subject will have to be determined by experimenting on engines in actual road service before any useful work in this connection can be done upon the testing plant.

Water Softening for Locomotive Use.

Committee—J. A. Carney, L. H. Turner, F. N. Risteen, J. F. Dunn, Robert Quayle.

There are two classes of waters commonly used for locomotives—scale-forming and alkaline. In both the impurities remain in the boiler either to form an accumulating scale or a concentrating alkaline solution, or both. The scale-forming material can either be removed from the water by heat or by chemical means. There is no known means of removing the alkali. The advantages of supplying a boiler with a clean water practically free from scale-forming material are shown by the boiler records of roads fortunate in having first-class water supplies, where fireboxes last almost indefinitely and flues are reset only when the beads are worn off.

The first attempt at water purification and general railroad practice in this country was to use a boiler purge—soda-ash or some allied sodium salt—generally put into the locomotive tank. This process precipitated the scale-forming material in the boiler as mud, and also tended to loosen up the scale already formed in the boiler, but it did not lessen the number of necessary washouts to any extent and required frequent blowing off, which did not effectually remove the mud, and, in addition, there was an accumulation of alkali in the water in the boiler not easily controlled. Theoretically, a boiler purge for purifying water in the boiler was nearly perfect, but practically it was not so successful. Treatment of water in the boiler has the advantage of being cheap, and that is all.

In order to obtain the pure water condition of a few of our fortunate neighbors, the practice of purifying the water before it enters the boiler has come into extensive use. The lime and soda-ash treatment has been used in some form or other for a great many years, but the mechanical devices for making the process successful, as well as economical, are of recent origin.

It is not the province of this committee to discuss the merits or demerits of the various mechanical devices on the market; further than to say, that they all work on one principle, namely, use enough soda ash (sodium carbonate) to precipitate the sulphates of calcium and magnesium as carbonates, and enough slaked lime (calcium hydrate) to neutralize the carbonic acid existing as free carbonate and bicarbonate, precipitating all of the carbonates of lime and magnesia in the water and also precipitate as carbonate all of the hydrate of lime added in the treatment process. The process is theoretically perfect and in practice leaves so little scale-forming material in the water that the beneficial results are most apparent.

There are two systems of treating waters; the continuous and intermittent. The continuous system consists of a device for mixing the required quantity of slaked lime and soda-ash in the water as it flows into a receptacle of such size that the slow flow of the water permits the precipitated scale-forming material to settle out, delivering continuously the purified water. Some continuous processes apply a filter to make sure that the sediment is removed from the water. This is believed to be a valuable addition to any plant where such a filtering process would be considered an addition. The advantage of the continuous process is that it takes up a minimum ground space. The intermittent system consists of treating the water and letting it settle and pumping the purified water from the top of the settling reservoir, using a floating intake pipe. The advantage of this system is low first cost. The settling process requires agitating machinery and time, and a settling plant can not be forced beyond its capacity without jeopardizing the quality of the purified water. In both systems the cost of chemicals is the same for a given water. The labor cost ought to be the same, if the men doing the pumping can be located so they can attend to the filter as well as the pumps.

Muddy waters are easily cleared of the greater part of the suspended matter, but it is almost impossible to render them absolutely clear unless a coagulant, ferric hydrates or alumina, is used. The slight murkiness in treated muddy water is not seriously objectionable, however.

Filtering plants are more complicated and more expensive than either the continuous or intermittent systems and usually depend upon a partial settling in order to relieve the filters from becoming quickly clogged. They deliver the cleanest water of any of the purifying processes, but it is a question whether the water is enough better to warrant the increased cost.

The quality of waters which can be treated successfully and with great benefit to locomotive boilers are those which may contain mud, sulphates of lime and magnesia, and carbonates of lime and magnesia, or which may contain salts of iron and free acid. Many alkali waters contain large quantities of incrusting solid. These can be removed, but the alkali remains and increases by the amount of soda-ash used. If the water is high in alkali, it will give trouble from foaming, and the probability is that it will be more economical to hunt up a better supply somewhere else that can be treated successfully. The results obtained from the treatment of dolomite waters are entirely successful, resulting in better steaming engines, greater tonnage hauled and a marked reduction in engine failures from leaking flues.

Analyses of waters containing from 5½ to 60 grains of incrusting solids per gallon show reduction by the treatment ranging from 3 to 5 grains of incrusting solids per gallon.

Alkali waters are those containing salts of sodium and potassium in solution, and there is no known chemical means of removing these salts. There are a number of articles on the market which claim to relieve troubles from foaming with alkali waters and some of them are partially successful. It is not, however, the province of this committee to discuss their merits or demerits. The only way to get rid of alkali is to remove the water from the alkali. This can be accomplished by distillation, but up to the present time the cost of plant and comparatively high cost of product make the process prohibitive for railroad use.

A purifying plant, 500,000-gallon capacity daily, can be erected for from $6,000 to $10,000, according to the process used, and the water successfully treated for scale-forming material, for from ¾ cent to 4 cents per 1,000 gallons, depending upon the quality of the water.

By the use of pure water, boiler troubles are reduced to a minimum. One railroad reports that the number of trains abandoned account leaky flues was reduced from 27 to 2 in a stated period. Another reports that passenger trains delayed account leaky flues on a division using purified water have been reduced from 12 to 15 per month, to 1 and 2, and an occasional month with no failures. A road handling 60 engines per day has reduced its boiler-maker force from 4 to 2 men—one day and one night—and these men have to be given machinist work to keep them busy.

Your committee does not recommend the use of compounds to be introduced into the boiler where there is a possibility of purifying the water before it reaches the boiler.

Your committee believes that the cost of purifying water for locomotive use is more than saved by the reduction in the labor cost of caring for boilers in the roundhouse, and the benefit gained by freedom from leaky flues and poorly steaming engines on the road is all profit.

Locomotive Terminal Facilities.

Committee—D. R. MacBain, C. E. Chambers, P. Maher, W. R. McKeen, Jr.

"What can be done to reduce locomotive terminals to the basis of a machine for treating and handling of engines apart from the matter of housing, the object being the prompt handling of power, greater efficiency in service and less detention at terminals, while affording more time and better facilities for care and repair of engines?"

Plan No. 1, which is shown in attached diagram, will be offered as the "old plant made over." It will be noted that the space available, at the time the change was made, was very limited, and the engineering department had to cut to fit conditions. A description of the plan is as follows:

The coming-in track, upon which all engines are left by the road crew.

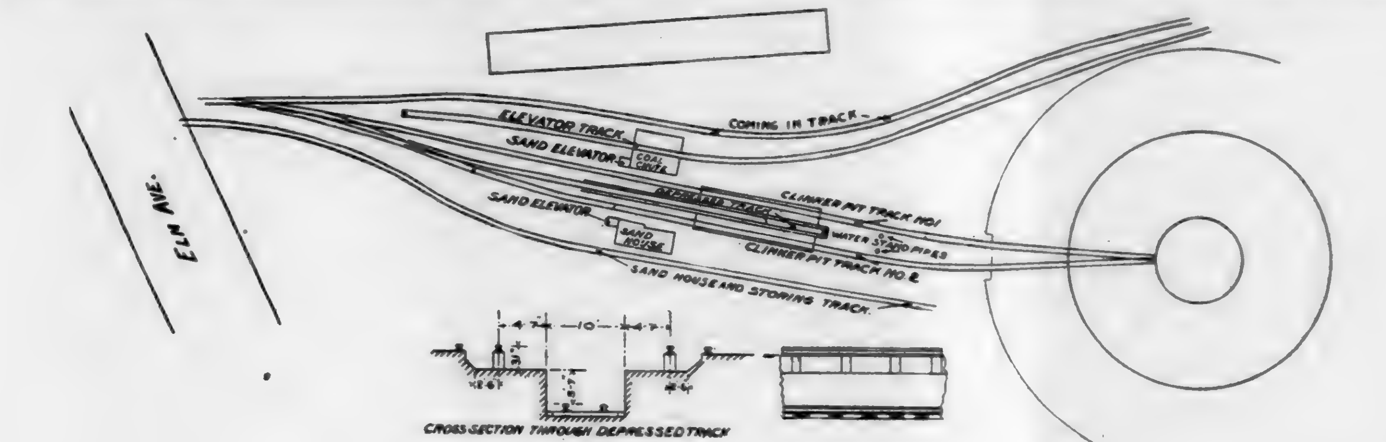
An elevator track, stubbed at one end and with sufficient rise for its whole length in the clear, to enable elevator men to move cars on or off the hoppers at will by the manipulation of the hand brakes and perhaps a little start with a pinch bar. Power is also provided for the movement of cars on and off the hopper, but is seldom used.

Clinker-pit tracks Nos. 1 and 2, both of which run to the turn-table direct, and the depressed track for cinder cars, the approach of which is laid on a 2 per cent. grade.

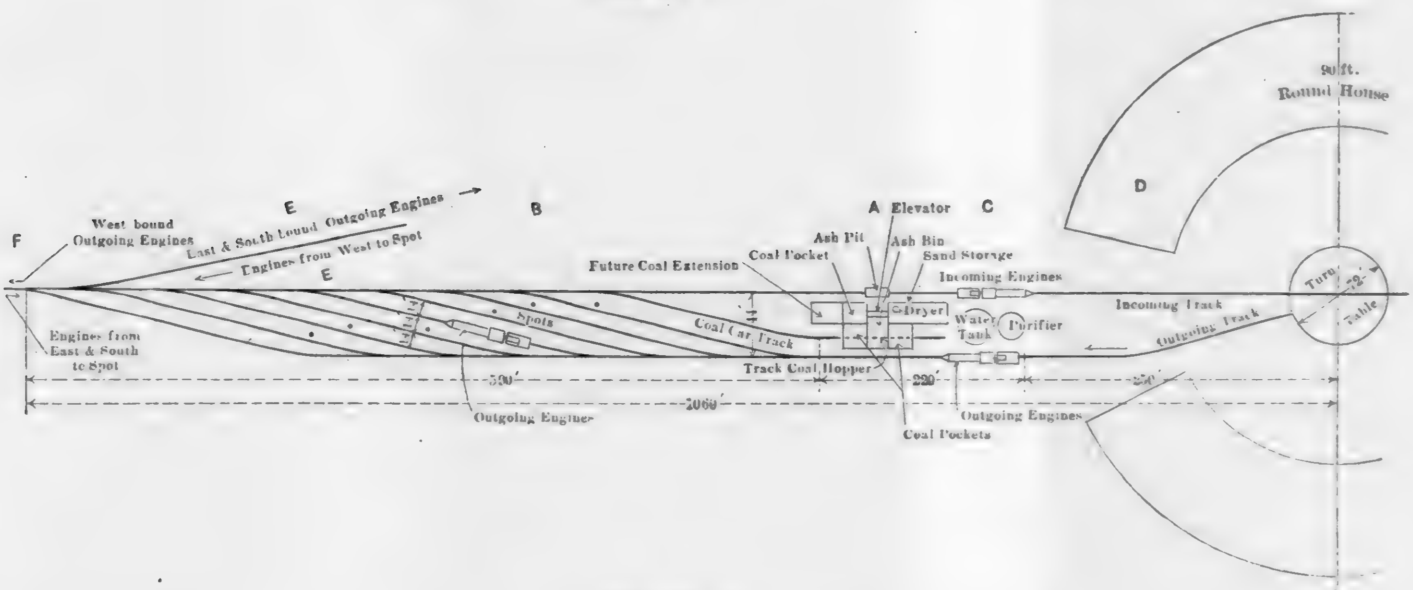
The coal elevator, which is the latest improved type of the Chicago Link Belt Company, and has a capacity of 500 tons.

The sanding boxes, which are placed as follows, one on the corner of the coal elevator adjoining the clinker-pit track No. 1, and another adjoining clinker-pit track No. 2 on the corner of the sandhouse proper. The sanding of engine is done by means of drop pipes, which are handled by hostlers, the time required for filling the largest boxes being about fifteen seconds. The sandhouse is equipped with three stove dryers, and sand is elevated into sanding boxes by means of compressed air. Storage is provided for about twelve carloads of wet sand, which is unloaded from cars placed on sandhouse and storing track. The sanding box on clinker-pit track No. 2, on sandhouse proper, is large, having a capacity of about ten cubic yards, and out of this box sand needed for outside points is loaded into cars placed on sandhouse track, by means of a drop spout or chute. Nine or ten yards of sand in this way can be loaded in a few moments.

Each of the clinker-pit tracks is provided with a 10-in. water column, and tenders are filled very quickly, the filling of tenders being the last operation before engines are put on the turn-table. This is not as the plant was planned, it being intended that the knocking out of the fire should be the last operation, but conditions of space made that impracticable.



PLAN NO. 1.



PLAN NO. 2.

LOCOMOTIVE TERMINAL FACILITIES.

The cross-section of the clinker-pit track shows the general plan, the inner rail (100 lbs. per yard) being supported on cast iron piers which are jacketed with No. 10 iron, the remaining space on the inside filled with concrete, tie rods at 10-ft. spaces being provided along open space of clinkering tracks to prevent possibility of rails spreading. The clinker pits and depressed track are of solid concrete and good drainage is provided. Two hydrants are provided on each clinkering track for wetting cinders, and a steam pipe is provided for thawing out ash pans and grates when such is needed.

In preparing this plan it was sought to make it as near a "machine" as possible, and the results obtained during the past winter were not disappointing in that respect.

Engines arriving off the road are left on the "coming-in track," and when they come in in quick succession, as is the rule in the winter or during any season of heavy traffic, no attempt is made to coal all of them on the north side of the elevator, hostlers usually alternating—that is, one is coaled on the north side and the next on the south side, or, if necessary, several engines are taken off the coming-in track at once and coaled up on clinker-pit track No. 1. In this way it will be observed that when necessary to get hold of, say, the sixth engine in line, the first five engines can be taken at once on to clinker-pit track No. 1, and the engine that is most desired can then be coaled on the coming-in track, after which it can be taken around on to clinker-pit track No. 2, sanded, clinkered, watered and housed, in from fifteen to twenty-five minutes from the time of its arrival.

All engines when going out for trains use a track provided for that purpose alone, and in no way interfere with the putting in of engines, except when on the table. The outgoing track is also provided with a water column to serve engines leaving the house.

The regular equipment of men is six hostlers and six clinker-pit men, three of each for the day and night shifts, respectively, and 100 engines are handled in twenty-four hours without difficulty or rush.

In addition to the duty of clinkering, the clinker-pit men also attend the switches at west end, unload the wet sand, run the dryers, elevate sand to sanding boxes, attend to water columns and shovel the cinders on to the cars on the depressed track.

The equipment of men for the coal elevator is one elevator man, one dumper and one loader for each of the day and night shifts, or seven men all told, including the fuel foreman.

At the present time coal is being handled from the car to the tender for 3 7-10 cents per ton, and this could be reduced considerably if enough coal was used to keep the help around the elevators busily employed.

Your chairman considers this plant as approaching closely to the "machine" idea and of sufficient capacity to handle 200 engines per day of twenty-four hours without difficulty.

Plan No. 2, as shown on the attached diagram, provides, as will be noted, a set of tracks upon which incoming engines can be spotted by the road crew, where they are left until the hostlers take them out for coaling, clinkering and housing. The object of the spot tracks is to permit of the last engine to be the first one housed, if such is desired. This plan, it will be noted, requires a lot of space, longitudinally at least, and perhaps could not be utilized at all points on this account. We quote in full the recommendations of Mr. W. R. McKeen, Jr., the designer of this plan:

"Railroads are just commencing to realize the importance and necessity of adequate roundhouse facilities. Efficient results from roundhouses have always been demanded, but necessary facilities have, as a rule, been sadly neglected. Following are some of the important facilities a roundhouse should have:

"1. What is known in the yard language as a 'spot'—a system of tracks connected to the inbound track in the yard, also connected to the main coal track leading to the roundhouse table; this system of tracks to be so designed as to enable at least ten engines to be delivered by inbound engine crews, any one of which can be moved to coal chute in preference to the other nine at any time.

"2. An outbound 'spot' track and a water crane, so that outbound engines could take a full tank of water just before leaving; also water cranes so that inbound trains could take water immediately after taking coal.

"3. A double cinder pit and means of wetting down and cleaning ash pans economically.

"4. Method of loading cinders into the ordinary steel car equipment by means of conveyors.

"5. Turn-table not less than 85 ft. with (preferably) an electric motor as power for handling same.

"6. Door with at least 35 per cent. glass for lighting purposes; also locks at top and bottom and posts so that same could be locked open as well as locked shut.

"7. Smoke-jacks so arranged that engines could be moved a quarter of a turn and equipped with suction ventilators so that the harder the wind the stronger the up draft.

"8. A system of ventilators on top of the roundhouse for catching the steam and other waste products from a locomotive.

"9. Water pipes, air pipes, blow-off pipes, steam pipes and a good-sized steam supply pipe and taps for these for each pit.

"10. A permanent, sanitary, dry floor; not a gravel or cinder floor, but a concrete foundation with wooden blocks set on edge, filled in between with tar and cement, and so fitted in as to drain any water into the pits.

"11. A toolroom for the care of all general roundhouse tools.

"12. A washroom for engine crews, lockers for their extra clothing, etc.

"13. Centrally located office and telephone facilities for the foreman.

"14. The low, flat roof of roundhouses is to be discouraged on account of the drippings in cold weather, and the impossibility of properly ventilating same."

Regarding subject "B," heating and ventilating of roundhouses, your committee can offer no suggestion for an improvement over the plant of the Lake Shore & Michigan Southern Railway, at Elkhart; this, in our opinion, being perfection itself along that line. (See description of the new Elkhart roundhouses, AMERICAN ENGINEER, February, 1905, page 42, and March, page 80.)

THE TIME SERVICE OF LOCOMOTIVES.

Committee—William Forsyth, H. Bartlett, J. S. Chambers, D. Van Alstyne.

It is worthy of note that the reports for time "in road service," plus the time "held at terminals ready for service," are fairly constant between 70 and 75 per cent. One road gives this figure for freight engines, accurately obtained by having special observers follow certain engines for a month, at 77 per cent.

It is reasonable to conclude from the tabulated reports that engines are ordinarily in the hands of or at the disposal of the transportation department three-fourths of the time, and this department is responsible for the large proportion of delays which so materially limit the mileage at present obtained from locomotives.

In order to obtain definite information in detail, it would be advisable to obtain accurate records at each large terminal for at least one engine in each representative run, and to do this a man

TABLE I.—TIME SERVICE OF LOCOMOTIVES ON VARIOUS RAILROADS.

NAME OF RAILROAD.	Percentage of Total Time—100 Per Cent.					
	On the line in Service.	At Terminal Ready for Service.	Held for Roundhouse Repairs.		Shopping.	
			Heavy.	Light.	Held Waiting.	Under Repairs.
C. B. & Q. lines east of Mo. River—Average of 445 locomotives	32.	57.	.....	.....	.....	11.
C. B. & Q. lines west of Mo. River—Average of 5 locomotives	23.9	47.7	.....	28.4	.....	.....
C. B. & Q. lines west of Mo. River—Average for 11 heavy locomotives	35.6	40.3	.....	24.1	.....	.....
Lehigh Valley—Average for 12 locomotives. E. & C. Branch Auburn Division	33.	53.	3.	8.	.....	3.
Lehigh Valley—Average for 20 locomotives	67.	2.	3.	4.	6.	18.
Union Pacific. Wyoming Division—Average for 32 locomotives	45.7	18.4	6.3	11.7	5.3	12.6
Union Pacific. Nebraska Division—Average for 147 locomotives	46.	28.	4.	10.	2.	10.
Southern Pacific. Pacific System—Average for 297 light locomotives. Month of January	21.75	46.25	5.	7.	5.	15.
Southern Pacific. Pacific System—Average for 415 locomotives, weighing over 100,000 lbs.	24.	36.	3.3	10.7	4.	22.
Southern Pacific. Salt Lake Div.—Average for 40 locomotives	58.	20.	2.	10.5	.....	9.5
Oregon Short Line—Average for 156 locomotives	40.	47.	3.	.....	.....	10.
Boston & Maine—Average for 44 locomotives. Heavy and light. All classes of service; 3 months	52.4	38.9	1.3	2.8	0.6	4.0
Boston & Maine—Average for 422 locomotives. One year.	.....	.....	.....	.....	2.7	6.6
Grand Rapids & Indiana Ry.—Average for 18 locomotives, weighing over 100,000 lbs., one month	61.8	12.4	.....	16.7	.....	9.1
Grand Rapids & Indiana Ry.—Average for 19 locomotives, weighing under 100,000 lbs., one month	57.6	16.	.....	14.5	.....	11.9
Chicago, Indianapolis & Louisville R. R.—Average for 99 locomotives	47.85	34.37	2.46	7.71	0.19	7.42
C. I. & L. R. R.—Average for 41 light locomotives	60.02	20.10	1.79	11.61	0.34	6.14
C. I. & L. R. R.—Average for 19 100,000-lb. consolidation locomotives	47.11	33.45	4.96	7.79	0.15	6.54
C. I. & L. R. R.—Average for 13 ten-wheel locomotives	28.16	53.97	2.38	2.46	0.19	12.84
C. I. & L. R. R.—Average for 26 150,000-lb. freight locomotives	39.03	47.73	1.75	4.11	.....	7.38
Seaboard Air Line—Average for 319 locomotives. All classes	89.9	.....	.....	10.1	.....	.....
Norfolk & Western	86.	3.4	0.1	1.7	0.3	8.5

TABLE II.—RECORD OF LOCOMOTIVE SERVICE FOR ONE ENGINE, ONE MONTH IN FREIGHT SERVICE. JANUARY 6 TO FEBRUARY 5, 1904.

TOTAL TIME OF TEST.	Hrs.	Min.	Hrs.	Min.	Per Cent.
			714	42	
MOTIVE POWER.					
1. Ash Pit (divided from average of a number of timings).					
(A) Waiting to get over pit	52	51			
(B) Cleaning fires	12	06			
(C) Coal and water	31	05			
2. Time in roundhouse for repairs	55	49			
3. Engine crew late	3	57			
4. Engineman not having engine ready	1	29			
5. Late leaving ash pit	2	08			
6. Repairs to machinery unfinished	1	56			
Total time in hands of Motive Power Dept.			161	21	22.6
TRANSPORTATION.					
(A) Delays due to Transportation Dept.:					
1. Making up trains	10	00			
2. Switching	26	48			
3. Passing trains	133	14			
4. Trains ahead	40	37			
5. Orders	21	34			
6. Block	6	01			
7. Delays at R. R. crossings	1	40			
8. Yards blocked	10	24			
9. Section men	..	50			
10. Due to wrecks ahead	7	41			
11. Train crew late	..	32			
12. Waiting for orders in roundhouse	40	28			
13. Waiting on train at yards	2	01			
14. Coal and water on road	24	30			
15. Cleaning fire on road	7	33	333	53	46.8
(B) Delays due to Motive Power Dept.:					
1. Locomotives not steaming	1	23			
2. Hot bearings	1	48			
3. Drawbars	4	27			
4. Couplers	1	22			
5. Cleaning front end	..	30			
6. Due to air brakes	4	13	13	43	1.9
(C) Running time, not including taking coal and water on the road	205	39	205	39	28.7
Total time in hands of Transportation Dept.			553	15	77.4
AT ENGINEHOUSE.					
1. Ash pit	96	02			
2. In house for repairs and care	59	53			
3. Detained at house waiting for crew	5	26			
4. Waiting at house for orders	40	28			
Total			201	49	
AT YARDS.					
1. Making up trains	10	06			
2. Putting away trains	5	12			
3. Waiting on trains and orders	3	28			
4. Yards blocked	17	55			
5. Block	2	41			
6. Motive power delays	2	16			
7. Running time between house and yards	6	53			
Total				31	
ON ROAD.					
1. Passing trains	128	36			
2. Trains ahead	37	44			
3. Switching	21	36			
4. Orders	20	07			
5. Block	3	20			
6. Miscellaneous	10	43			
7. Cleaning fire and taking coal and water on road	32	03			
8. Motive power delays	11	27			
9. Running time	198	46			
Total			464	22	
Grand total			714	42	

Total mileage on road	3129.	miles.
Average running speed (miles per hour)	15.2	"
Average equivalent speed for transportation time	5.7	"
Average equivalent speed for total time of test	4.4	"
Mileage on fast freight	348.	"

DISTRIBUTION OF TIME WAITING FOR ORDERS IN ENGINEHOUSE.

	Per Cent. of Total Time.	Hrs.	Min.	No. of Times at House.
At Terminal A	40.	16	13	9
At Terminal B	34.6	14	00	7
At Terminal C	25.4	10	15	7

TABLE III.—RECORD OF LOCOMOTIVE SERVICE FOR ONE ENGINE, ONE MONTH IN FREIGHT SERVICE.—JANUARY 6 TO FEBRUARY 5, 1904.

SUMMARY.	Hrs.	Min.	Per Cent.
Charged to Motive Power—At Roundhouse:			
Waiting to get over ash pit	52	51	
Cleaning fires	12	06	
Coal and water	31	05	
Total	96	02	
In roundhouse for repairs	55	49	
Minor delays due to men	9	30	
Total time in hands of Motive Power Dept.	161	21	22.6
TRANSPORTATION.			
Making up trains	10		
Switching	26	48	
Passing trains	132	14	
Trains ahead	40	37	
Orders	21	34	
Yards blocked	10	24	
Wrecks	7	41	
Waiting at roundhouse for orders	40	28	
Coal and water on road	24	30	
Cleaning fire on road	7	33	
Sundry small delays	12	04	
	333	53	46.8
Delays due to M. P.—Not steaming, hot boxes, drawbars, brakes	13	43	1.9
Running time	205	39	28.7
			100.
Total time in hands of Transportation Department	553	21	77.4
Time at enginehouse	201	49	
Time at yards	48	31	
Time on road	464	22	
	714	42	
Running time	198	46	

must be especially assigned to the engine and keep accurate record of the time of all its movements.

To show the detail into which such a report can be divided, an actual record is here given of the complete time service of one locomotive for one month in freight service. It will be seen that the total time in the hands of the motive power department was 22.6 per cent., and in the transportation department 77.4 per cent., and that the delay due to motive power while on the road constituted but 1.9 per cent. of the total time. The average running speed was 15.2 miles per hour, but the total mileage, divided by the time in the hands of the transportation department, is equivalent to only 5.7 miles per hour, and the average equivalent speed for the total time of test, 4.4 per hour.

Your committee is of the opinion that records relating to the time service of locomotives are worth keeping in considerable detail, and that numerous delays can be checked up in this way which do not appear to be noticed or obtained by ordinary methods.

Subjects for 1906.

Committee—J. F. Deems, William McIntosh, R. D. Smith.

INDIVIDUAL PAPERS.

1. The more general application of white metals for bearings of locomotives.
2. Special valve gears, such as the Walschaert, Alfree-Hubbell, Young, etc., compared with the ordinary Stephenson link motion, by C. J. Melin.
3. Fire kindling; cost of material, labor and time kindling fires in locomotives, with both anthracite and bituminous coal, by F. F. Gaines.
4. Superheating steam in locomotive practice, by F. J. Cole.

SUBJECTS AND COMMITTEES.

Best method of welding and repairing locomotive frames without taking down or removing from the engine.—William Garstang, C. H. Quereau, G. W. Wildin.

Organization of the Mechanical Department, with special reference to the question as to whether the Mechanical Department or the Transportation Department should employ, examine, promote, govern and discipline locomotive firemen and engineers.—D. Van Alstyne, J. H. Manning, G. M. Basford.

What can be done to establish a general understanding of a uniform method of designating repairs on locomotives in railroad repair shops, in order that reliable comparisons can be made as to the efficiency of various shops on any one system, or possibly as between the shops of various systems or roads.—H. H. Vaughan, R. Quayle, C. W. Cross.

Engine house running repair work on locomotives; what is considered the best practice for doing this work, handling reports, etc., made by foremen, engineers, road foremen of engines, and inspectors, and with what machine tools and hand tools should the roundhouse be equipped to get the best results?—A. E. Mitchell, F. T. Hyndman, J. W. Luttrell.

Locomotive lubrication; general consideration of the subject, with reference to high steam pressures and superheated steam; how far may we economize in lubrication, both internal and external; also consider standard fittings for lubricators; consider question of sight-feed lubricators versus pumps for internal lubrication.—E. D. Bronner, R. F. Kilpatrick, D. Van Alstyne.

Specifications covering cast iron to be used in cylinders, cylinder bushings, cylinder heads and steam chests; also the question of substitution of cast steel for locomotive cylinders, the idea being to secure lighter section with better material.—G. R. Henderson, E. D. Nelson, Max Wickhorst.

Results obtained from water-purifying plants.—L. H. Turner, H. T. Bentley, W. R. McKeen.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Tests of M. C. B. Couplers.

Committee—R. N. Durborrow, J. Buker, W. S. Morris, W. P. Appleyard, F. H. Stark.

The question of the adoption of a standard design of automatic coupler was forcibly brought out by the president in his address before the convention last year, and was later referred by the Executive Committee to your Coupler Committee for consideration. As this is probably the most important coupler question which has come before the Association since the adoption of the M. C. C. contour lines in 1888, there can be no doubt that there is urgent need for some concerted action by the railroads of the country looking toward a reduction of the large number of types of couplers now in use, with a view of eliminating those of weak design and poor construction. The large sums of money invested in the great variety of coupler parts necessary to carry in stock at repair yards is alone a convincing argument that some action should be taken to relieve the present conditions.

The ideal arrangement would be the universal use of but one design of coupler, and the future policy of the association must depend upon the question as to how near and in what manner to approach this ideal. After deliberate consideration of the various phases of this subject, your committee has concluded that it would be best not to offer any definite recommendation as to the policy to be adopted; but it would suggest that the association consider the following schemes in whatever action may be taken:

First. That the Coupler Committee be empowered to act in conjunction with a specially appointed committee (in which should be included representatives of the manufacturers) to early decide upon a composite design of coupler which shall contain as far as possible the desirable features of the best couplers as now designed, and that all patent rights involved be waived and all manufacturers be permitted to manufacture the composite coupler as adopted.

Second. That the present policy of the association be followed out—that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency, and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competition.

In presenting this subject your committee asks for a full discussion at the present convention and urgently requests that immediate action be taken to formulate definite instructions to the Coupler Committee as to the policy to be pursued. Your committee deems this subject of vital importance and believes that it should not be delayed.

The specifications for M. C. B. couplers have been used, in practically their present form, since 1901, and are to-day giving satisfaction as a check on the design, workmanship and the material in couplers. That good results have not been universally felt is due to the reluctance of the railroads to buy their couplers under these specifications; although the specifications are far from being in general use, it is the opinion of your committee that the time has come when action should be taken by the association looking toward enforcing their use.

The large number of break-in-twos, nearly all of which can be attributed to coupler failures, is abundant testimony to the fact that many couplers are not what they ought to be; and anything to improve them should be eagerly taken up. The earlier the railroads can be induced to use these specifications the earlier will an important step have been taken toward a decrease in the number of these break-in-twos, and the consequent expensive accidents.

Believing that the present annoyance from coupler failures demands some acton, and that the results will justify the action, your committee recommends that the specifications for M. C. B. couplers, which are at present recommended practice, be advanced to standard as a step toward enforcing a higher efficiency in our couplers and relief from delays to traffic due to their failure. Making the specifications a standard of the association will necessitate some minor changes in their reading to avoid repetition of features already standard.

Recommendations.—1. Present specifications for M. C. B. couplers, which are now recommended practice, with the modifications and additions suggested in the body of this report, be made standard.

2. Worn coupler limit and wheel defect gauge (Drawing "A") be adopted as standard, superseding wheel defect gauge on M. C. B. sheet 12, and annulling worn coupler limit gauges shown on M. C. B. sheets "A" and "G."

3. Knuckle designed not to pull out when knuckle pin fails be adopted as recommended practice.

4. Knuckle throwing device be adopted as recommended practice.

5. Knuckle lock lift to be in the central longitudinal vertical plane, located between the striking horn and contour lines, and operate from the top by an upward movement, be adopted as recommended practice.

6. That the additional dimension, "Not less than 20¾ ins." be added on the plan view of 5 x 7-in. coupler on M. C. B. Sheet 11,

to definitely locate the point at which the shank shall measure 7 ins.; this dimension will prevent designers from moving the 1-in. radius (connecting the head and the shank) back too far, thus reducing the lateral coupler clearance in the carrier iron below the prescribed limits.

7. That the coupler "Tail End for Continuous Draft," shown on M. C. B. Sheet 11, be removed as being unsuited for approved practice in car construction, as recommended by the Committee on Draft Gear in its report to the convention of 1904.

8. The enlarged butt for the 5 x 7 shank from friction gear, as shown on Drawing "C," (not reproduced) be adopted as recommended practice, to conform to the yoke for butt, recommended by the committee on Draft gear last year.

Air-Brake Hose.

Committee—L. G. Parish, T. S. Lloyd, F. H. Scheffer, G. H. Emerson, J. Milliken.

Your committee submits herewith report covering results of tests at Purdue University to determine the condition of hose in service at various ages. This report covers a total of 500 hose which were removed from actual service and tested. The laboratory report gives a full description of the testing plant and describes the manner in which the hose were tested; also the age of hose, the manufacturer's name and brand. A study of the data herein given leads the committee to recommend the submission of the specifications proposed last year to the convention as a standard in lieu of the present M. C. B. standard specifications for hose.

The committee would reaffirm the recommendation made in the report last year, i. e., that the location of the angle cock and train pipe has not been given proper attention. The M. C. B. recommended practice specifies that train pipe be located thirteen (13) ins. from the center line of car, and that the angle cock be turned to an angle of thirty (30) deg. Your committee would again recommend that this be made a standard.

Attention is called to the necessity of having the air brake pipe securely fastened, to prevent vibration. These features are not being watched as closely as they should. The improper location of the train pipe and angle cock brings about a condition fully as bad as pulling cars apart without uncoupling hose by hand. The standard 22-in. hose is of sufficient length if the angle cock and train pipe are located as per M. C .B. recommended practice. If, however, the train pipe is located over 13 ins. away from the center line of car, and the angle cock vertical, the distance is greatly increased, and when the slack is taken out of the couplers the hose is ruptured, on account of vertical strain. The laboratory tests indicate that the majority of burst hose is due directly to the conditions mentioned above.

The committee would recommend to the Arbitration Committee the incorporation of the following rule in the Rules of Interchange:

"On and after March 1, 1908, cars offered in interchange must be equipped with M. C. B. standard hose; if not so equipped owners are responsible for the application of standard hose."

The committee would recommend that 2,000 additional hose be tested during the coming year in order to definitely determine the age limit of air brake hose. Attention is called to the fact that we have at Purdue University an air brake hose testing plant which is available for the use of our members.

Truck Arch Bars for 100,000-lb. Marked Capacity Freight Cars.

Committee—J. E. Muhlfeld, A. S. Vogt, W. T. Gorrell, C. E. Fuller, F. M. Gilbert.

Your committee on this subject submits the following report:

Realizing the wide difference in opinion of railroad mechanical men with respect to the various types of truck arch bars in use on freight cars, the weight of which, including lading, is 150,000 lbs., it was decided to submit a list of questions to all members of the association for the purpose of obtaining data and information pertaining to the practice of railroads operating under similar and different conditions.

Replies to the circulars of inquiry were given by 14 railroads and car builders, and from the information received, your committee suggests that the following conclusions shall be submitted to the convention for adoption:

The Distance Between Wheel Centers to Be 5 Ft. 6 Ins.—Ten replies out of the total number received specified this spacing, which your committee considers necessary to provide a sufficient amount of room for a substantial design of truck bolster and column castings, and for the proper suspension of inside brake beams and application of brake heads and shoes.

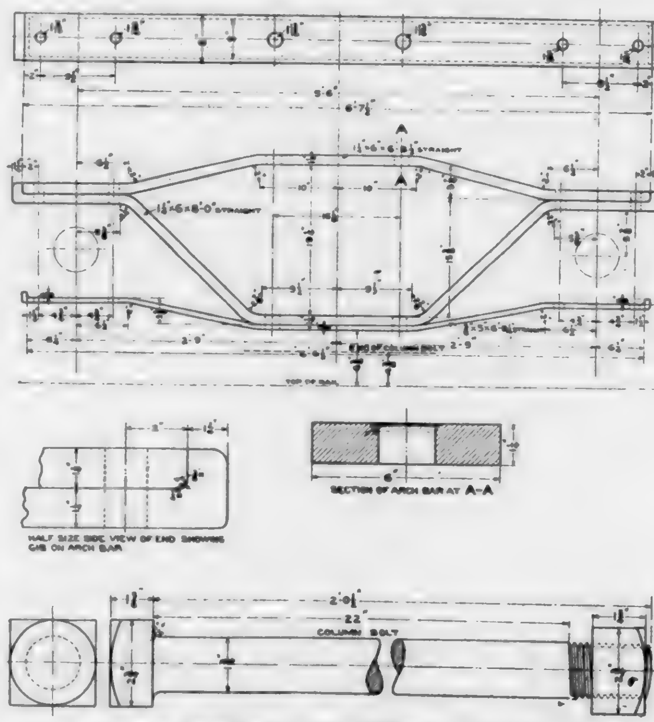
The Cross Section of the Top and Inverted Arch Bars to Be 6 x 1¼ Ins.—The tendency has been, and will be, to increase the average loading per car, especially in the vicinity of the coal, ore, structural steel, quarry and other districts where business originates which will necessitate the use of the greatest proportion of 100,000 lbs. and heavier capacity equipment. It has been found that sections of inverted arch bars 5 x 1¼ ins. have failed within a few years after having been put into service. These failures have occurred principally in the bends at the base of the column castings and through the column bolt holes, and an examination has indicated that even with a good quality of wrought iron material and proper truck construction detail and entire fractures have developed at these points. Furthermore, the column bolt holes have shown a slight tendency to elongate, with a corresponding reduction in the thickness of the section, indicating that there is not sufficient metal at this point for the stress. The replies, as well as the practice in vogue at the present time, indicate the necessity for making use of a section larger than 5 x 1¼ ins., and in order to provide for the best distribution of metal at the weakest point in the inverted arch bar, it has been thought advisable to increase the width to 6 ins. The reasons for increasing the cross sectional area by widening rather than by thickening the arch bars are, greater strength with equivalent weight, more lateral stiffness, reduced liability for over-straining, less distortion of cross section in forming, greater uniformity in the section and quality of material, and reduced expense for construction and maintenance. It is not considered necessary to have a larger section of top arch bar than inverted arch bar, and the advantage to be derived from making both sections of the same dimensions is apparent.

The Section of Tie Bar to Be 5 x ⅝ Ins.—Seven of the replies received specify the use of tie bars 5 x ⅝ ins., and from the general information given, as well as the results from practice, it is thought that this section will be entirely satisfactory in connection with the 6 x 1¼-in. arch bars.

The Inverted Arch Bar to Be Gibbed to Provide a Bearing for Each End of the Top Arch Bar.—This practice is recommended, as from service and drop and other tests, it has been found that a bearing for the ends of the top arch bar against the ends of the inverted arch bar will produce greater stability, provide for the maximum benefit from the top arch bar, and at the same time reduce the shearing effect on the journal box bolts. It will also increase the strength and stiffness of the arch bar frame as a whole and give a greater factor of safety under the increasing average loads to be carried.

The Tie Bars to Be Gibbed at the Ends.—This practice is recommended for the reason that service records indicate that the wear on the threaded portion of the journal box bolts and the elongation by wear of the journal box bolt holes in the tie bar have been considerably reduced where the gibs were used, and this result is considered an advantage that will justify the application of this feature.

The Set of the Top Arch Bar to Be 3⅞ Ins.—From the replies received, three specify the use of the 3⅞-in. dimensions, two



PROPOSED ARCH BARS FOR 100,000-LB. FREIGHT CARS.

3¾ ins., and the others vary from 1 to 5 ins. The five railroads using the 3⅞-in. and 3¾-in. set represent a freight equipment of 334,645 cars, of which 71,355 cars are 100,000 lbs. capacity.

The Distance Between the Top and Inverted Arch Bars to Be 19¼ Ins.—General design and practice have indicated that this dimension is the proper one to be used with the set of 3⅞ ins. for the top arch bar, and in connection with the M. C. B. truck bolster spring, in order to provide for sufficient depth and strength at the end of the truck bolster, as well as space for a substantial spring seat which will clear the through bolts securing the ears of the column castings to the spring channel.

The Set of the Inverted Arch Bar to Be 15⅜ Ins.—The set of the top arch bar and the distance between the top and inverted arch bars having been determined, the above dimensions must follow.

The Set of the Tie Bar to Be 3⅜ Ins.—This dimension is determined by the M. C. B. journal box.

The Distance from Center to Center of Column Bolt Holes to Be 16⅛ Ins.—This spacing has been found sufficient to provide for a suitable design of truck bolster giving ample transverse strength. It will also provide for sufficient strength in either cast iron, malleable iron or cast steel column castings, and accommodate the use of M. C. B. bolster springs.

All Column and Journal Box Bolt Holes to Be 1-16 In. Larger Than the Diameters of the Bolts.—This will conform to the established practice.

THE DISTANCE BETWEEN THE TOP OF THE TRACK RAILS AND HE BOTTOM OF THE TIE BAR TO BE 6⅜ INS.—It is thought that he above dimension should be adopted to provide the necessary pace for the M. C. B. bolster springs and substantial truck bolsters, and give sufficient clearance between the top of the bolster nd the under side of the top arch bar.

THE DISTANCE BETWEEN THE TOP OF THE TRACK RAILS AND HE LOWER END OF THE COLUMN BOLTS TO BE NOT LESS THAN ⅜ INS.—The features considered in the establishing of this disance are the required clearance at road crossings, for Wharton pe switches, etc., and allow for the usual wear of journal bearigs, journals, treads of cast iron wheels, and for the reduction in iameter of steel-tired and rolled-steel wheels.

THE DIAMETER OF THE COLUMN BOLTS TO BE 1¾ INS. AND HESE BOLTS TO BE FITTED WITH COMBINED WASHERS AND NUT OCKS AT THE HEAD OF THE BOLT AND AT THE NUT, AND WITH HE UNITED STATES STANDARD SQUARE HEADS AND NUTS. THE OP ARCH BAR TO HAVE THE COLUMN BOLT HOLES COUNTERUNK ON THE UPPER SIDE TO TAKE A ¼-IN. RADIUS FILLET NDER THE HEAD OF THE COLUMN BOLT . . .

THE RADII AT THE BENDS OF THE TOP ARCH BAR TO BE 2 INS., ND TO THE INVERTED ARCH BAR AT THE COLUMN CASTING 2⅞ NS.

THE RADII OF THE INVERTED ARCH BAR AT THE JOURNAL BOX TO BE 2¼ INS.

ALL OTHER DIMENSIONS TO CONFORM TO THE PRESENT M. C. B. STANDARDS.

THE MATERIAL PREFERABLE FOR ARCH AND TIE BARS AND COLUMN BOLTS IS GOOD WROUGHT IRON, THIS BEING BETTER ABLE TO WITHSTAND DISTORTION WITHOUT DETAIL OR ENTIRE FRACTURE.—When the best quality of wrought iron is not attainable, a good medium carbon, low phosphorus and sulphur, open-hearth steel can be used for arch and tie bars. The use of Bessemer steel is not recommended under any circumstances.

GENERAL.—The cuts as shown by Plate No. 1 accompanying this report show a top and inverted arch bar, tie bar and column bolt of the recommended design and dimensions for cars, the weight of which, including lading, is 150,000 lbs., as well as for modern freight and switching locomotive tenders, where the use of helical springs is permissible. With the use of the four coil nest of helical springs and a substantial spring seat casting and channel there is no necessity for any additional reinforcing over the inverted arch bar between the truck column castings.

Your committee believes from a general standpoint that the recommended design and specifications as included in the eighteen sections and Plate 1 can be adopted with satisfactory results, and provide for the greatest strength and factor of safety to resist the stresses due to ordinary wear and tear, curvature, lateral thrust, braking action and derailment.

VENTILATION.

The accompanying illustration shows the construction of the Royal ventilator which has proved very successful in ventilating buildings, power houses, train sheds and factories. The construction is very substantial and the design is such that rain and downward currents of air are deflected without materially interfering with the free egress of air from the interior and it is always effective when the wind blows and will not choke in a calm. The diameter of the upper cone is enough greater than that of the lower one to deflect rain and

SHOWING CONSTRUCTION OF ROYAL VENTILATOR.

snow outside of the neck of the ventilator. The lower cone deflects the upward current of air from the body of the ventilator and in so doing offers only a very slight resistance and does not produce choking eddies or counter currents. In the larger ventilators patent radiating ribs are formed in the cones which make a very rigid construction and add greatly to the ventilating capacity. No matter which way the wind blows an exhaust current of air is induced from the building. Because of the large area of discharge a comparatively small number of these ventilators are required to properly ventilate a building. They are made by the Royal Ventilator and Manufacturing Company of Philadelphia.

HEAVY TONNAGE.—The average tonnage carried per mile of road on the Pittsburgh & Lake Erie Railroad last year was 121,607 tons, or almost twenty times greater than the average tonnage per mile carried on all the railroads of this country for a corresponding period.

COMPRESSION IN STEAM CYLINDERS.—The following is taken from a review in *The Engineering Magazine* of an article by Dr. Herbert Klemperer in the *Zeitschrift des Vereines Deutscher Ingenieure*, which reports and discusses some very careful tests made at the technical high school in Dresden. Dr. Klemperer states: "The condition under which compression is advantageous is that the temperature at the end of the compression shall not exceed that of the cylinder walls, so that the maximum economical compression at the end of the stroke is that corresponding to the temperature of the walls." If the compression is increased beyond this point the economy of the engine will fall off, and according to the experiments at Dresden, the steam consumption will increase in proportion to the ratio of the volume of the compressed steam to the volume of live steam in the cylinder.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

SAFETY VALVES.—The American Steam Gauge & Valve Manufacturing Company of Boston, are sending out a circular which contains an interesting description of the American special pop safety valve.

FROGS, SWITCHES AND CROSSINGS.—A 375 page catalog has just been received from the Weir Frog Company, Cincinnati, O., manufacturers of frogs, switches, crossings and all kinds of regular and intricate track work.

SOME REASONS WHY.—The Otto Gas Engine Works, Philadelphia, Pa., have issued a folder which describes in an interesting manner the advantages of their gas engines and calls attention to several good reasons why buyers should select these engines.

ELECTRIC GENERATORS.—The Crocker-Wheeler Company, Ampere, N. J., are sending out bulletin No. 53, which describes their direct current, lighting and power generators, and also bulletin No. 55 on small generators arranged for direct connection.

EXHAUST FANS.—Catalog No. 180 from the American Blower Company, of Detroit, Mich., describes their "A B C" exhaust fans which are specially designed for the removal and conveying of shavings and dust, the removal of smoke and fumes, and for use in connection with special heating and drying plants.

TABOR INDICATOR.—We have just received from the Ashcroft Manufacturing Company, 87 Liberty Street, New York, a catalog describing the latest type of Tabor Indicator; also the Houghtauling reducing motion, the Ashcroft reducing wheel, the Coffin averaging planimeter and various indicator parts and supplies.

THE LEWIS & CLARK EXPOSITION.—The Westinghouse Electric & Manufacturing Company have issued a very attractive pamphlet for distribution at this exposition at Portland, Ore. It illustrates and briefly describes the line of apparatus manufactured by this company, specially referring to the apparatus on exhibition and to actual installations of apparatus.

PROGRESS REPORTER.—The July number of the "Progress Reporter," published by the Niles-Bement-Pond Company, New York, briefly describes and handsomely illustrates some of the machine tools furnished by this company for the Angus Shops of the Canadian Pacific Railway at Montreal. Interesting facts are presented concerning the output of some of the machines.

ELECTRIC GRINDERS AND BUFFERS.—Bulletin No. 48 from the Northern Electric Manufacturing Company, Madison, Wis., describes the various Northern electric grinders and buffing equipments which are equipped with speed regulating devices so that the speed may be varied to compensate for the varying diameters of the wheels. These grinders are of special design and construction and have heavy crucible tool steel armature shafts, liberal bearings and dust-proof covers.

JEFFREY SCREENS.—The Jeffrey Manufacturing Company, Columbus Ohio, have just issued a supplement to their screen catalog N. 69.

PLANERS.—The Cincinnati Planer Company, Cincinnati, O., has issued an attractive catalog describing its line of planers which has been completely redesigned. Special attention is directed to the devices which they furnish for obtaining a variable cutting speed with a constant return speed. There is also a valuable chapter on the erection and care of Cincinnati planers.

DON'T BURN MONEY.—A pamphlet of 12 pages, issued by William B. Scaife & Sons Company, 221 First avenue, Pittsburgh, Pa., presents engravings illustrating the application of the Scaife or We-fu-go system of water purification. These applications are for railroad and manufacturing service, indicating the progress which has been made by this company in introducing this system.

ROTARY PLANING MACHINES.—Catalog No. 41 from the Newton Machine Tool Works, Philadelphia, Pa., describes a number of their rotary planing machines, which are made in various sizes, having cutter-heads from 26 to 100 ins. in diameter over the tools, and which are made either plain, portable, on circular sub-base or mounted on a long bed to face off both ends of the work simultaneously. A number of special machines are also shown.

GRINDING MACHINES.—"A Treatise on Tool Room Grinding and Grinding Machines" has just been published by the Cincinnati Milling Machine Company. It describes their No. 1 universal cutter and tool grinder and also their No. 2 machine which has been designed especially for sharpening the large spiral and face mills. Directions are given for the care and operation of these machines and a large number of illustrations show how various operations are performed. It also contains valuable information concerning reamer clearances and emery wheels.

AXLE LIGHT SYSTEM.—Bulletin No. 1 from the Consolidated Railway Electric Lighting and Equipment Company, 11 Pine Street, New York, contains an interesting description of their axle light system of electric lights and fans for passenger cars. That this system is giving satisfactory results is shown by the fact that a list is given of twenty of the largest railways in this country, who use this system of electric lights and fans on many of their best cars. In addition the officers cars on many of the other leading railroads, as well as all Pullman private cars, are equipped with it.

NOTES.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.—The Los Angeles, California, office of this company has been removed from the Trust Building to 527 South Main Street.

CRANE COMPANY.—This company has moved its general offices and sales departments to its new office building at 519 South Canal street, Chicago, near the Judd street plant.

AMERICAN WATER SOFTENER COMPANY.—During the month of June this company received two orders for water softening plants from the Norfolk and Western Railroad, to be installed in their coal lands in West Virginia. This makes a total of three orders from the railroad company since April 1st.

THE CRANE COMPANY.—This company celebrated its 50th anniversary on July 4th. All of the company's branch house managers took part in the celebration, and the festivities lasted for four days. As a souvenir of the anniversary the company is sending out metal elephants to be used as paper weights.

BIG CRANK SHAFTS.—The Bethlehem Steel Company is at work on three crank shafts which will weigh 86,600 lbs. each when finished. They are turned out of solid steel ingots 25 x 4 x 4 ft., and are intended for three Snow gas engines, which are to drive 4,000-k.w. Crocker-Wheeler alternators, the largest gas engine driven generators ever built, ordered by the California Gas and Electric Corporation.

SCALING PIPES BY PNEUMATIC HAMMERS.—A valuable discovery in scaling and cleaning pipes, particularly of condensers, is that a pneumatic hammer striking rapid, uniform, light blows is better than anything else which has been devised. It does not crack the pipes, or spring the joints and requires about one-fourth the time to clean a condenser involved in old methods. Mr. A. P. Anderson, of the Consumers' Ice Company of Chicago, has used the pneumatic hammer very successfully in this service, our attention having been called to this fact by the Chicago Pneumatic Tool Company of Chicago.

THE WARNER & SWASEY COMPANY.—Mr. G. D. Mitchell, formerly of the United Shoe Machinery Company, but better known as the Jones & Lamson expert, with which company he has been connected for the past five years, has just become associated with The Warner & Swasey Company, in the capacity of western representative.

WILLIAM B. SCAIFE & SONS COMPANY.—This company has been awarded the contract for all the structural steel work in connection with the Port Falls, Idaho, power plant to be built for the Washington Water Power Company of Spokane. They have also designed and will erect a steel frame trestle approach 200 ft. long for the American Lime and Stone Company at Frankstown, Pa.

CROCKER-WHEELER COMPANY.—This Company has declared a regular quarterly dividend of 1½ per cent. and re-elected the following officers: Schuyler Skaats Wheeler, President; Gano S. Dunn, Vice-President and Chief Engineer; W. L. Brownell, Treasurer; G. W. Bower, Assistant Treasurer. The directors are Professor Francis B. Crocker of Columbia University; Dr. Wheeler, Messrs. Dunn and Doremus, A. Foster Higgins, Herbert Noble, Thomas Ewing, Jr., F. L. Eldridge and C. A. Spofford.

INDEPENDENT PNEUMATIC TOOL COMPANY.—This company recently acquired the Aurora Automatic Machinery Company of Aurora, Ill., makers of the Thor piston air drills; pneumatic riveting, chipping, caulking and beading hammers; piston air motor hoists; pneumatic saws and other air appliances. The general offices of the Independent Company are in the First National Bank Building, Chicago, Ill., and the Eastern office is at 170 Broadway, New York. The works at Aurora, Ill., are equipped with the very latest improved machinery, the present capacity being about 100 pneumatic tools per month. The officers and board of directors include a number of names very well known among the railroad and machinery supply interests.

FARLOW DRAFT GEAR.—The Farlow Draft Gear Company exhibited at the Master Mechanics' and Master Car Builders' Association conventions a full-size model, showing the combination of the Westinghouse draft gear with Farlow attachments. This exhibit received much favorable comment, and this draft gear itself received noteworthy recognition in the Master Car Builders' convention in connection with the decision not to abandon the slots in coupler shanks. This gear has been described in this journal and its special features pointed out. It is so designed that the parts may be assembled and applied by one man. The riveted yokes and follower plates are eliminated, and the stresses are distributed throughout the length of the draft sills from the end sill to the body bolster. The initial stress, to the extent of the capacity of the friction device, is received by the rear key and filler block. After the coupler has travelled 2½ ins. the horn comes into the bearing against the buffer plate. The front key has then travelled to its bearing on the cheek plate, and the front block has travelled from the center key to its bearing upon that key; this makes six seperate points of contact for the distribution of the stresses. In pulling, the front and rear keys travelling ahead of the bearing in the cheek plates, the middle key being stationary. The load is therefore carried to the draft sills at three separate places. In either pulling or buffing the coupler is free to adjust itself laterally.

LAKE MEMPHREMAGOG.—This lake, in Northern Vermont and Canada, is one of the most charming resorts in the Green Mountain State. This lake is 30 miles long and 2¼ miles wide, and over two-thirds of its length is in Canada. In early days a favorite haunt of the Indians for fishing and camping; it was named by them Memphremagog, meaning "beautiful water." The steamer "Lady of the Lake" leaves Newport sailing the entire length of the lake to Magog, occupying about four hours. The view as witnessed from the decks of the steamer is magnificent; the charms of the rocky and uneven shore; the towering cliffs, the long stretches of green forest land and the distant peaks of Owl's Head and Oxford Mount, with intervening sweeps of beautiful valley land, present a panorama which appears more beautiful at every turn. The "Switzerland of America" this region has been called, and many people see in Memphremagog another Loch Lomond, while the Canadian portion has frequently been termed the "Geneva of Canada." In order to get a comprehensive idea of the marvelous scenic surprises of this region send two cents in stamps to the general passenger department, Boston & Maine Railroad, Boston, for their beautiful illustrated booklet, entitled "Lake Memphremagog and About There," and two cents for the companion booklet, entitled "Valley of the Connecticut and Northern Vermont."

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CONTENTS.

WALSCHAERT VALVE GEAR AND CONSTANT LEAD

To the Editor:

I have been very much interested in the articles on the Walschaert valve gear appearing in the AMERICAN ENGINEER, particularly in that on page 218 of the June number. Its use, as well as the introduction of superheated steam and the four-cylinder balanced compound, shows that the American designers are looking across the Atlantic for valuable information, and finding it. In doing this, however, they have, in my opinion, obtained some information which is not correct.

That the Walschaert valve gear has very decided advantages under the conditions now governing the design of American locomotives there can be no doubt, but it does not necessarily follow that the feature of a constant lead for all cut-offs and speeds is desirable.

In the article in the June number it is stated that it is difficult, with the Stephenson valve gear, "to obtain sufficient lead with large cylinders in the longer cut-offs and at the same time keep down the lead and consequent preadmission and excess of compression in the shorter cut-offs." This assumes that the lead for the longer cut-offs is an advantage for large cylinder engines. A little farther on in the same paragraph this assumption is stated as a fact, the reason given being that a constant lead for all cut-offs "properly cushions the reciprocating parts—saving steam and reducing the pounding of bearings."

The fact that lead is not needed, under ordinary conditions, to cushion the reciprocating parts seems evident from the fact that the rods and reciprocating parts of locomotives never run so smoothly or with such freedom from pounding as when running with the throttle closed. It is a fact, which can be easily proved by observation, that there is practically no pounding when drifting at any speed from the highest to the lowest, even though the parts are decidedly worn and loose. Then why provide lead for the purpose of cushioning?

Assuming, however, for the sake of argument, that lead is desirable for cushioning the reciprocating parts, does it seem reasonable that the same amount of lead gives the proper cushion for all speeds? The clearance volume of the cylinder to be filled with a steam cushion is the same for all speeds, hence the time necessary for filling it with the proper pressure must be the same for all speeds, and it follows that this cannot be accomplished, with a constant lead, which necessarily shortens the time for filling the cylinder as the speed increases. The fact is that the cushion for a speed of 40 miles an hour should be sixteen times that for 10 miles an hour, because the inertia of the reciprocating parts increases as the square of the speed. It seems hardly reasonable to believe this can be obtained with the constant lead of the Walschaert valve gear for both these speeds.

Careful tests made with an indicator, and covering a considerable period of time, confirmed by the experience of a considerable number of American railroads as given in the proceedings of the Western Railway Club for February and March, 1897, to which could be added the present standard practice of several other lines, seem to prove beyond reasonable doubt that positive lead at full gear is a detriment instead of an advantage, and that a reasonable negative lead for full gear is an advantage. A little study of the matter will show the reason.

Assuming that a quarter of an inch is the proper lead for a cut-off of one-fourth the stroke, it is evident that, with the Walschaert valve gear, the steam port will be open a quarter of an inch when the crank pin is on the center with the engine in full gear. Under these conditions it is plain that the steam pressure in the cylinder can no more perform useful work in moving the locomotive than a man can by trying to lift himself by his boot straps, and is a positive detriment because it produces useless friction on the crank pins on that side of the locomotive, which imposes useless work on the engine on the other side where the crank pins are on the quarter and furnish the only power available for moving the locomotive.

When with the constant lead assumed and full gear cut-off the crank pin is approaching the center, steam will be admitted to the cylinder when the piston is about 2 ins. from the end of the stroke. Under these conditions the main valve is travelling very rapidly and the piston very slowly, so that boiler pressure is admitted to the cylinder almost instantly, and the results are a sudden taking up of all the lost motion in the rods, producing a severe pound, a needless sudden strain, and friction on all the moving parts, resulting in an appreciable waste of the power of the engine on the other side of the locomotive. If any one doubts this, let him try to pinch an engine off the center when the engine on the other side is disconnected. He will find it impossible with any ordinary pinch bar, though perfectly easy when there is no steam in the cylinder. If this experiment is tried when the lead in full gear is 1-16 in. negative it will be successful, because steam will not be admitted to the cylinder till it can do useful work in moving the locomotive. It, therefore, seems evident that, for speeds at which a full gear cut-off is used, positive lead, instead of being desirable, is just the contrary, and that the Walschaert gear is defective in this particular.

If lead is not needed to provide a cushion, what is its purpose? I would say to secure, as nearly as possible, boiler pressure in the cylinder by the time the piston reaches the end of the stroke, not before, and to increase the steam port opening after the crank pin has passed the center, so as to secure as high a steam pressure as possible in the cylinder up to the point of cut-off. If this is correct, it follows that the lead should increase as the speed of the locomotive increases, and the cut-off is shortened because, while the clearance volume to be filled is the same for all speeds, the length of time during which it must be filled decreases in the same proportion that the speed increases, if the lead is contant, while a lead which increases with the shorter cut-offs used with higher speeds, increases the time for the admission of steam.

Without fear of results, I venture the statement that locomotives having the Walschaert valve gear, if given the proper lead for the running cut-off, will be found to pound severely at the longer cut-offs and slower speeds, resulting in excessive wear to the parts involved, and will be found lacking in power on ruling grades, compared with locomotives having valve gear which increases the lead as the cut-off is shortened, and if given the proper lead for the longer cut-offs, will not have sufficient lead and will be lacking in power for higher speeds.

This statement should not be misconstrued as an opinion that the Walschaert valve gear does not possess advantages over the

Stephenson type, or, on the whole, will not prove the better of the two. It is simply an argument to correct the statement that a constant is better than a variable lead.

C. H. Quereau.

LEAKAGE OF PISTON VALVES.

To the Editor;

On page 255 of your July number, in "Impressions of Foreign Railway Practice" I note a reference to German experiments upon the leakage of piston valves without packing rings. Permit me to ask whether or not experiments have been made in this country, showing the relative amounts of leakage of piston and slide valves?

Inquirer.

Editor's Note.—Yes. The following quotation from the proceedings of the Master Mechanics' Association for 1904 describes such tests.—Editor.

On the Norfolk & Western Railway the method adopted for testing piston valves was to prepare a packing ring for each end of the valve chamber which could be brought up against the end of the valve, making it absolutely tight. This arrangement is illustrated in the report. The valve was then put on the central position on both sides of the engine and disconnected, and, being central admission valves, the steam could be readily admitted to the central portion, and whatever escaped passed down through each end of the cylinder. Pipes were connected up with the cylinder cock openings and the pipes passed through barrels of water, which condensed all of the escaping steam. In most cases gauges of mercury columns were placed on the cylinders and readings taken during the test. Three positions were taken of the valve: First, both valves on center; second, with the right valve ⅝ in. forward and left valve ⅝ in. back, and third, the right valve ⅝ in. back and the left ⅝ in. forward. In the positions ⅝ in. out of center, two of the rings are against the steam at one end. The results, however, do not seem to be affected by this.

The tests made for leakage of piston valves on the Lake Shore & Michigan Southern were conducted in the following manner:

The valve on one side of the engine was disconnected and set on center, and the reverse lever set so that the other valve, the one to be tested, was on center. A movement of the valves of about 1 in. was given during the test, by moving the reverse lever. The exhaust pipes were plugged so that no steam could pass to the other cylinder or out of the stack. Hose connections were screwed in the cylinder cock openings and steam condensed in barrels of ice water. The valve was well oiled and the lubricator kept running during the test.

Tests for leakage of side valves were made in the following manner on the Norfolk & Western: The valve tested had rectangular balance strips. The exhaust cavity was blocked and leakage was obtained around the balance strips, as well as the face of the valves.

On the Norfolk & Western, a piston valve in good condition loses from 250 to 400 lbs. of steam per hour. The worst valve tested on this road showed a loss of 544.31 lbs. per hour, with a mileage of 13,000 miles. The best slide valve on the Lake Shore & Michigan Southern showed a leakage of 348 lbs. per hour. This valve was in good condition, and had made a mileage of 17,500 miles.

The conclusions derived from these tests do not seem to favor either type of valve. The best piston valve shows a leakage of 268.56 lbs. per hour, and the best slide valve 348 lbs. per hour. If both kinds of valves were given equal attention the piston valve would be the better as regards leakage around the packing rings.

Efficiency of Men.—If one of us does £150 worth of work a year, and earns £100, he is efficient; if he only does £90 worth, he is an inefficient machine, and will come to grief. He is like a 90-k.w. alternator which takes 100 k.w. to excite, though the analogy is not close. If he does £15,000 worth of work and gets £10,000, he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realized. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero, his consumption being equal to his output. The man who does £15,000 worth of work and gets £10,000, consumes two-thirds of the work himself; so his efficiency is 33 per cent., which is very high, even for an engineer.—*J. Swinburne.*

LOCOMOTIVE BOILER INSPECTION IN NEW YORK STATE.

The question has been raised by a correspondent as to what New York State has done in the matter of legislation concerning the State inspection of locomotive boilers. As other readers may be interested, the recent amendments passed by the New York State Legislature and signed by the Governor, which are now in operation, are reproduced as follows:

Section 1. Chapter five hundred and sixty-five of the laws of eighteen hundred and ninety, entitled, "An act in relation to railroads, constituting chapter thirty-nine of the general laws," is hereby amended by inserting therein two new sections to be sections firty-nine-a and forty-nine-b, and to read as follows:

49-a. Inspection of Locomotive Boilers.—It shall be the duty of every railroad corporation operated by steam power, within this State, and of the directors, managers or superintendents of such railroad to cause thorough inspections to be made of the boilers of all the locomotives which shall be used by such corporation or corporations, on said railroads. Said inspections shall be made, at least once every three months, by competent and qualified inspectors of boilers, under the direction and superintendence of said corporation or corporations, or the directors, managers or superintendents thereof. The person or persons who shall make said inspections, shall make and subscribe his name to a written or printed certificate which shall contain the number of each boiler inspected, the date of its inspection, the condition of the boiler inspected, and shall cause said certificate or certificates to be filed in the office of the railroad commissioners, within ten days after each inspection shall be made, and also with the officer or employee of such railroad having immediate charge of the operation of such locomotive. If it shall be ascertained by such inspection and test, or otherwise, that any locomotive boiler is unsafe for use, the same shall not again be used until it shall be repaired, and made safe. A certificate of a boiler inspector to the effect that the same is in a safe condition for use shall be made and filed in the office of the railroad commissioners. Every corporation, director, manager or superintendent operating such railroad and violating any of the provisions of this section shall be liable to a penalty, to be paid to the people of the State of New York, of one hundred dollars for each offense, and the further penalty of one hundred dollars for each day it or they shall omit or neglect to comply with said provisions, and the making or filing of a false certificate shall be a misdemeanor. Any person, upon application to the secretary of said board of railroad commissioners and on the payment of such reasonable fee as said board may by rule fix, shall be furnished with a copy of any such certificate.

49-b. State Inspector of Locomotive Boilers.—Within twenty days after this section takes effect, the State railroad commission shall appoint a competent person as inspector of locomotive boilers, who shall receive a compensation to be fixed by the commission, not exceeding three thousand dollars per year. Such inspector shall, under the direction of the commission, inspect boilers or locomotives used by railroad corporations operating steam railroads within the State, and may cause the same to be tested by hydrostatic test, and shall perform such other duties in connection with the inspection and test of locomotive boilers as the commission shall direct. But this section shall not relieve any railroad corporation from the duties imposed by the preceding section.

A Good Investment.—One of the largest manufacturing establishments in the world has sent a bright young man from its Philadelphia office to a leading university to prepare himself by a college education for the financial end of the business. This was not an act of philanthropy, but an investment on the part of the concern. It is likely to prove another wedge which will open up a new departure in the education of enterprising young men now employed in industrial works. *—A. E. Outerbridge, before Wharton students.*

IMPRESSIONS OF FOREIGN RAILWAY PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

"Breakfast and booze" is the next entry in my notes. No one here seems to associate these two words, but they certainly play an important part in European shop practice. A few shops have changed to the working day of two periods, but it is not unusual for the men to come to work at 6 o'clock in the morning. They go home for breakfast and again for dinner at noon, thus cutting the day into small pieces. The custom is not satisfactory, and it cannot be made so. But it is not easy to change, so firmly intrenched has it become. One reason why the majority of the men like it is because they are quite dependent upon beer, and this system gives them an opportunity to go out for it. Numbers of cases were seen in the smaller German shops where the men had their beer in the shops where they could go for an occasional "pull" at the can while the machine worked on. Some were even willing to stop the machine for the purpose. To an American all this seems very strange. At this time of year (December) it is quite dark here at 7 in the morning, and it is considered a hardship for the women of the workmen's families to get up sufficiently early to provide a hot breakfast for the men in time to get to work at that hour. On one large railroad in England the advisability of providing hot breakfasts for the men at the shop is now being considered. At many large English shops mess rooms are provided for use at noon by all who live at considerable distance from the works. No cooking is done by the company, but the men's lunches are heated for them on steam tables and in ovens, and they may sit on benches in a large room and enjoy their noon hour at tables with the advantages of comfortable accommodations and pleasant surroundings which cost them nothing. The writer was invited to see the men at lunch at a shop where he happened to be at the noon hour. About 900 men sat at the tables and were evidently enjoying themselves. Why do not our railroads do this for their men? It costs little, but brings big returns.

Systematic circulation of technical papers is often a part of the work of the office staff of large engineering establishments, but probably no better use is made of them than at the works of A. Borsig, at Tegel. These works include locomotive, gas engine, stationary engine and boiler construction, each department requiring a special staff of engineers and managing officials. Every advance made in Germany or any other country is studied and applied, if possible, at Tegel. All of the important technical papers on mechanical and railroad subjects are received in the library of the firm. There are six employees who devote their entire attention to the current technical literature, to render it available for every one who may need it. All papers and magazines are carefully read in the library. The papers are marked in blue pencil, directing attention to valuable articles, and each paper starts on its rounds through the offices in a stout portfolio. A list pasted on the cover begins with the name of the head of the department interested, with the others in order below. Each one, to whom this paper comes, in turn sends it to the next one, reporting to the library its whereabouts. Every paper may be instantly located if needed, and when through its rounds it goes into the library for permanent file and binding. But this is not all. Every article is carefully indexed by the library staff, and in every possible way these people render this literature available, and therefore make it a working tool for those who need it. While the writer was looking over this system the chief engineer called for references on tests of superheaters as applied to locomotives. The references were at once found in the card catalogue, and a draftsman proceeded to the shelves of bound volumes for the desired information. Often the head of a department requests from his subordinates opinions in writing upon the descriptions of new designs or new developments, thus making sure that the papers are read in the right way. This interesting plan should have a place in every large industrial establishment. It is very noticeable that foreign engineers are careful readers of American papers, and are exceedingly well informed about American practice.

Another good plan is followed at Borsig's. In every shop a letter-box is put up in a conspicuous place, and the men are asked to submit in writing suggestions for improving the work of the plant or decreasing its cost. This is not original at Tegel, it is in use in many shops, but by close attention from Mr. Dorn, the manager of the works, fifty good suggestions have been put into effect in about a year and a half. The suggestions are usually accompanied by sketches, and sometimes by very good drawings. The subjects are gone into very carefully, and those having sufficient merit are put into effect, suitable records being made in a book. Employees receive cash prizes for their suggestions, the amounts varying from very little up to about $100. More than this would be paid for a specially good thing. This works very well in Germany, where the men are much steadier than in some newer countries. It should work even better in the United States, and it seems a little strange that railroads do not carry out an idea of this kind. It is said at Tegel that this plan has the effect of bringing latent talent to the front, and that it has served to interest the men more deeply in their work. In Germany our kind of labor difficulties are unknown. This serves to direct attention to the possibilities of applying a premium plan for new ideas to conditions like ours, in which the men are surrounding themselves with powerful leveling influences. Furthermore, a prize system of this kind would tend to lead every worthy workman in the shop to help the management to increase the efficiency of the plant. If introduced into a railroad shop, it might at first receive scant attention, and even scant courtesy, from the men, but there is no question of the value of the idea. At Tegel one of the workmen offered a suggestion with respect to the use of new high-speed tool steel in heavy lathe tools, which resulted in vastly reducing the cost of the tools. This man immediately received a substantial reward in money, and without doubt he will lie awake nights to work out other good ideas. A number of excellent improvements in methods have been made, and nearly all of them were unlikely to have been thought of by any one except the men who actually do the work. It might be an excellent plan to do something of this kind in connection with piecework. If a man knew that he would receive an immediate reward of $50 or $100 for suggesting a jig or some other short cut in his work he might feel more like presenting it.

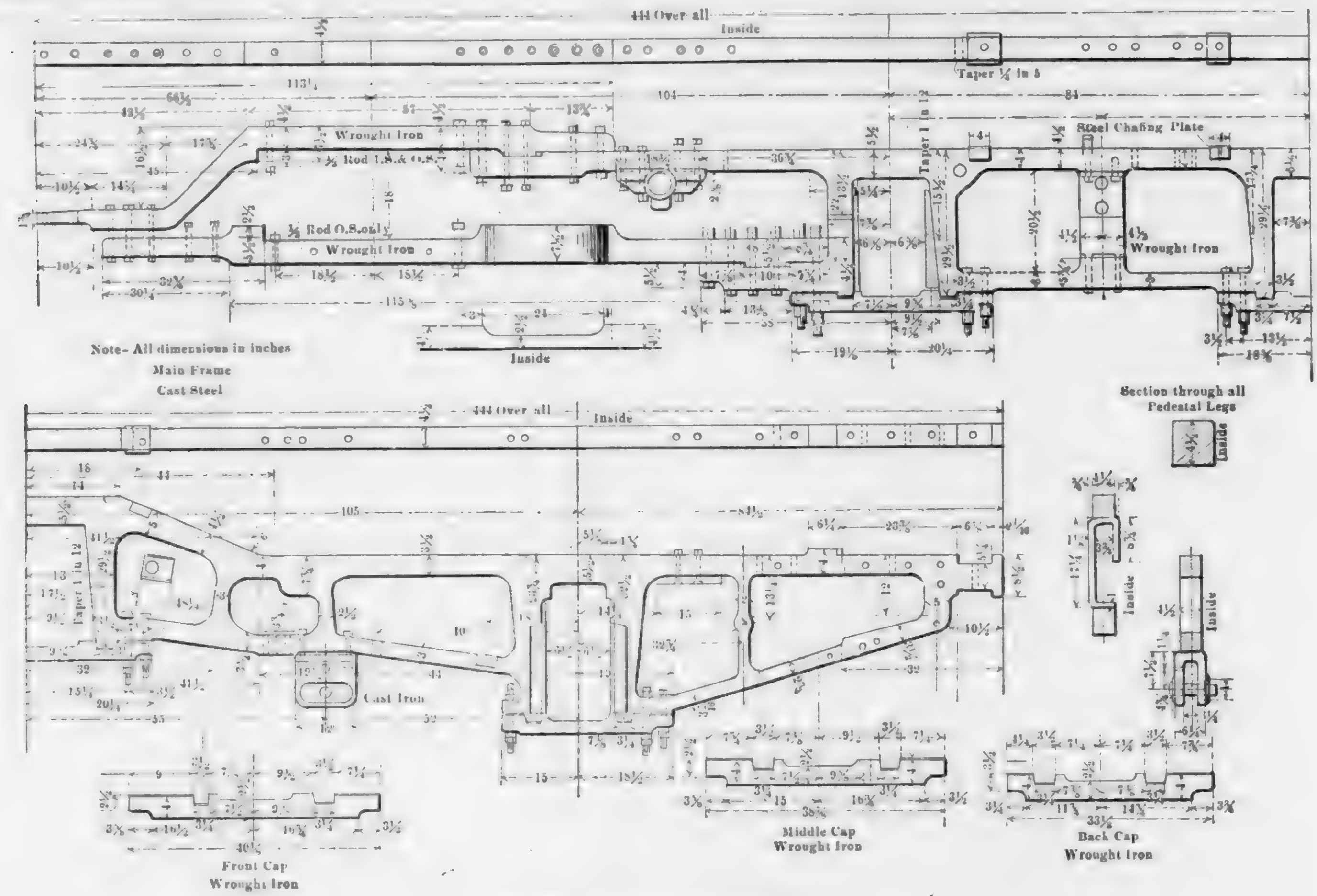
As I stood at the gate of a large Continental general engineering establishment, saying an appreciative word of thanks for the painstaking courtesies shown me, I heard a rattle and roar such as would be made by a cavalry charge on Broadway. It was the shop men's wooden shoes as they rushed out like stampeding cattle, happy to be out of the works and free from the shop restraint. I never saw anything like this at home.

G. M. B.

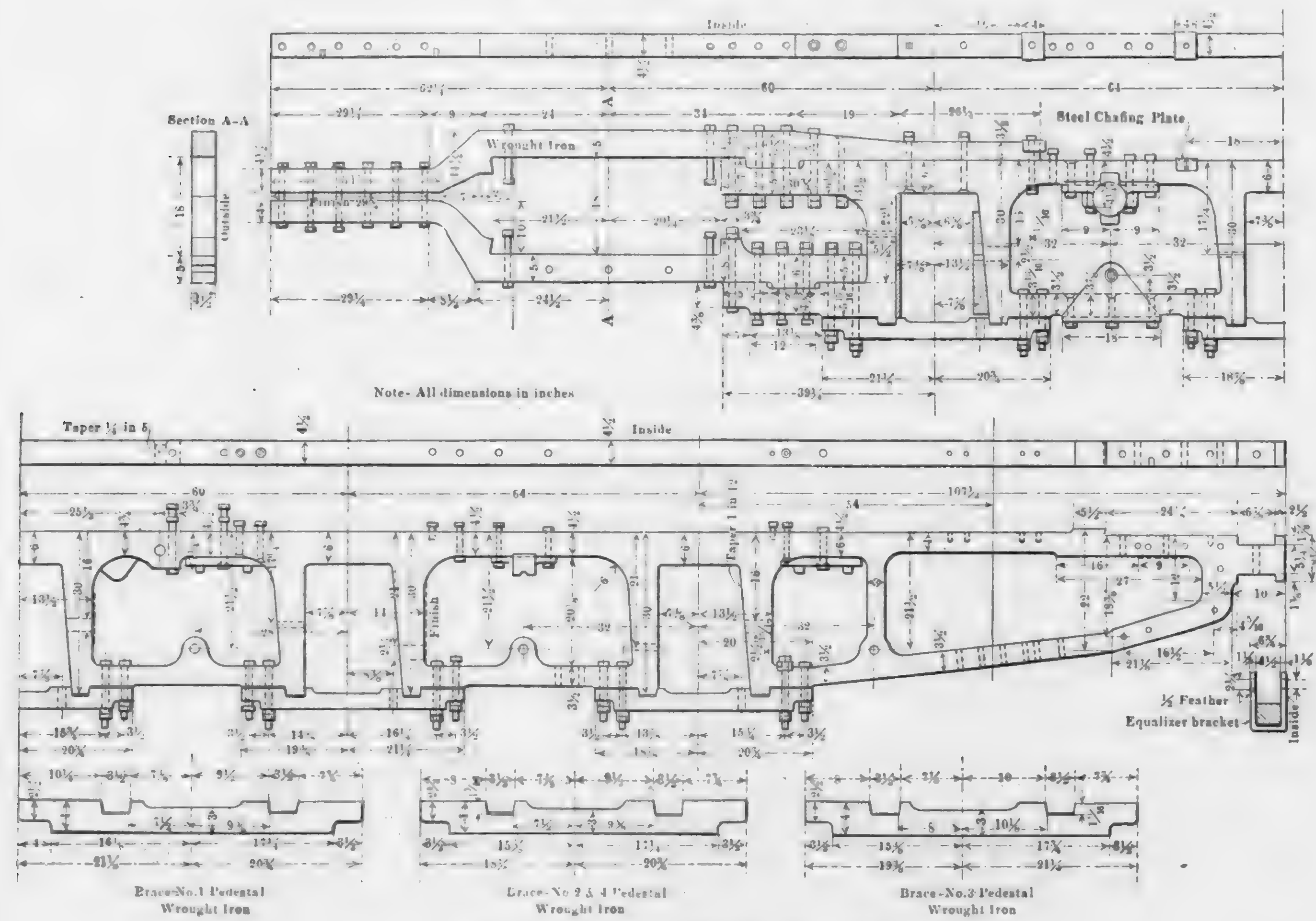
(To be continued.)

(To be continued.)

GET AFTER THE CAUSE, NOT THE EFFECT.—In general, do not worry and scheme to simply repair troubles, but remove the cause. If you are burning out tubes in your boilers and keeping gangs of men putting in tubes or cleaning the scale out of old ones, do not scour the market to find the best flue scraper or where a man can be got for $3 to take the place of a man you are paying $3.25, but remove the trouble and install a plant that will soften the water. It is an easy matter, usually, to prove the saving; if the management refuses to spend the initial sum, hammer away with facts about costs until they will spend it. One firm in this vicinity put in 200 tubes in two months at an average cost in place of $7.50 per tube, a total of $1,500 for two months. A water softening plant of the proper size would cost about $8,000, and would pay for itself in two to three years.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

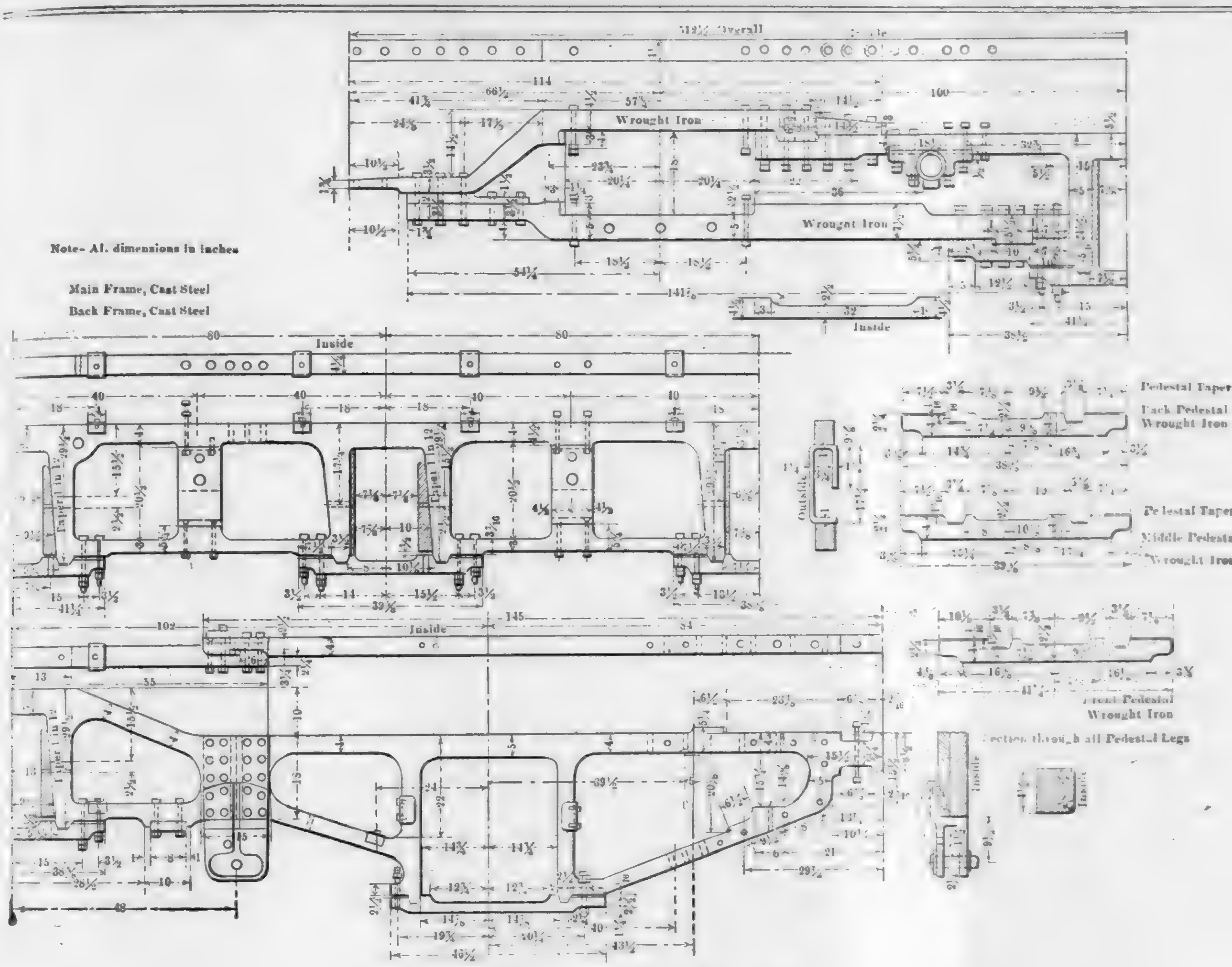


FRAMES, 4—4—2 (ATLANTIC) TYPE.

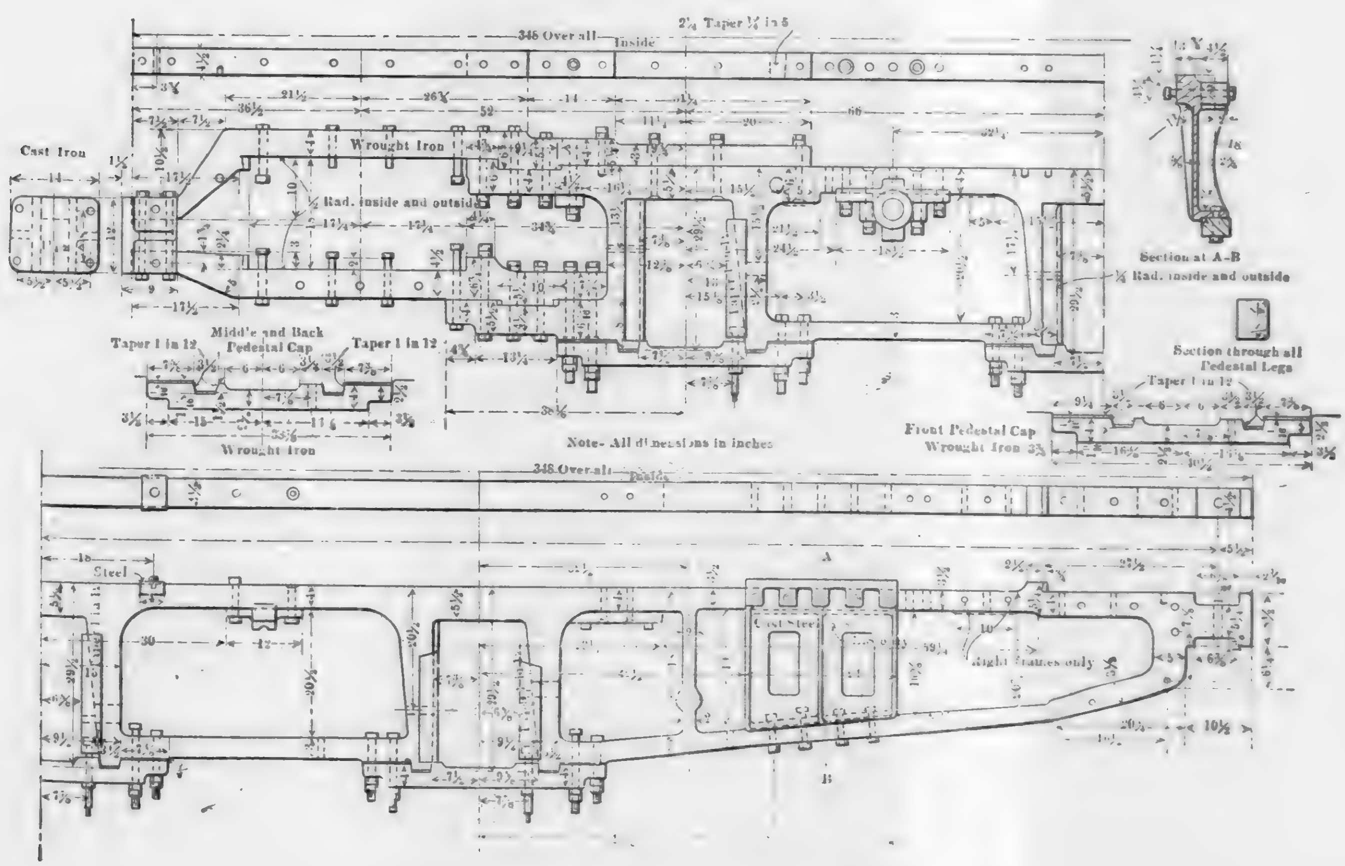


FRAMES, 2—8—0 (CONSOLIDATION) TYPE.

COMMON LOCOMOTIVE STANDARDS—HARRIMAN LINES.



FRAMES, 4—6—2 (PACIFIC) TYPE.



FRAMES, SWITCHING LOCOMOTIVES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

V.

(*For previous articles see pages* 154, 200, 250 *and* 288.)

FRAMES.—While the frames of these four types of standard locomotives differ necessarily for the different types of wheel arrangement, they were designed with a view of using the same principles throughout. They are all of cast steel, and the pedestals are arranged for the standard driving boxes, which were referred to in the June number, page 200, the driving boxes being in two sizes for 9 x 12 and 10 x 12-in. driving journals. The Atlantic and Pacific types of passenger locomotives have 10 x 12-in. main journals, all of the other boxes being for 9 x 12-in. journals, thus rendering it possible to use but two driving boxes for all engines. The rear ends of all the frames are alike, to receive the same deck plate. All the frames are 4½ ins. wide, and all are spaced at 43-in. centers. As far as possible the same cross sections of frames are used throughout, but the consolidation frames are ½-in. deeper throughout, in order to secure additional strength and weight. All the frames have rails 5½ ins. deep above the driving boxes, with the exception of the consolidation, which is 6 ins. deep at this point. The pedestal binders are all of rectangular section, secured by double bolts, no pedestal tie bolts being used in any of these frames. The joints in the lower rails, between the main frames and front sections, are provided with double keys throughout and the upper joints with single keys, this construction being the same as that illustrated in connection with the Pennsylvania Class H—6—A locomotives, illustrated in this journal in June, 1899, page 181. There is a marked similarity in the common standard frames, and the pedestal binders are practically the same, varying only in length. All the frames have double front rails.

Because of the use of the Rushton radial trailer truck on the Pacific type and the rigid trailer truck on the Atlantic type, due to its shorter wheel base, the rear portion of the frames of the passenger engines differ in detail construction, specially as effected by the pedestals for the trailer trucks. All the frames are protected by chafing plates of ¼-in. steel for protection against moving links from wearing into them. All joints are double nutted.

By referring to the general plans of the standard engines on pages 155 to 158, it will be seen that the boilers are supported from the mud rings by flexible plates in the case of the passenger engines, by flexible plates and sliding bearings in the case of the consolidation engines and by sliding expansion supports in the case of the switchers. In the design of these frames specially careful attention was given to the frame splices.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Company in furnishing the drawings.

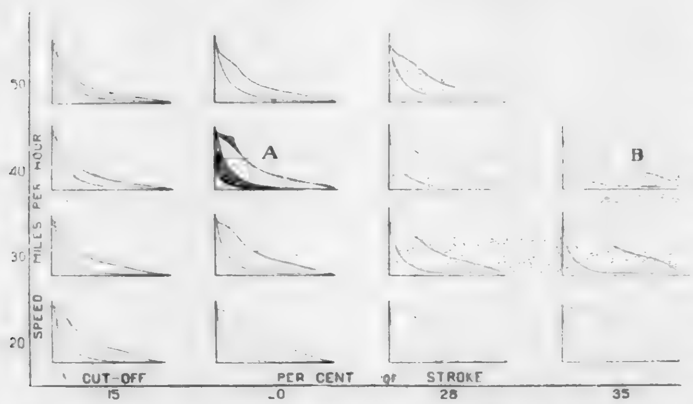
AUTOMATIC RECORDING INSTRUMENTS FOR POWER PLANTS.—One of the best devices for the control of a power plant is the automatic recording instrument recording steam pressure, voltage, current wattage, temperature on heating systems, pump speeds, etc. The most important in an ordinary power house are the steam pressure chart and voltage chart; the former records conditions in the boiler room, the latter, conditions in the engine room. The pressure line cannot be good unless the water level and fires are attended to, nor can the voltage line be correct if the switchboard is neglected. It is excellent practice to require that a written explanation of any irregularity in these charts be pinned to the chart, and an engineer or fireman with a too frequent repetition of bad charts should be discharged.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

DR. W. F. M. GOSS ON VALVE GEARS.

From the beginning of locomotive valve gears, countless devices have been proposed affecting either the valve or the gear which gives it motion, whereby the card may be made larger than that which results from the normal link-driven plain valve. A typical card is shown at A. Concerning such devices, I would note that it is usually assumed, though the assumption is erroneous, that anything which increases the area of an indicator card is desirable. For example, in the engraving, for 20 per cent. cut-off and a speed of 40 miles an hour (card A) the plain outline is the normal card around which has been drawn a so-called improved card. The difference is the shaded area, and is presumably the result of the adoption of some new form of gear. Obviously, the shaded area represents increase of power. The first mistake that is made concerning the change is that the increase in power results in no expense. Again, while the truth of the preceding statement may be admitted, it is often urged that one may measure pressure and volume represented by two indicator cards such as are shown by these cards and derive therefrom an estimate of the relative amount of steam used per horse power per hour under conditions which each represent. Such estimates are, in fact, fairly reliable when made between cards agreeing closely in form, and when all conditions of running are the same, but, as a general proposition, nothing is more misleading. If there are differences in speed, or in initial or final pressure, or in the number of expansions, the percentage of the total amount of steam used which is shown by the indicator will change. Anything which may produce a change in the temperature of the metal of the cylinder at any one point in its cycle is likely to produce changes in the whole cycle. As is well known, a considerable percentage of the steam drawn from the boiler for each stroke of the engine condenses on entering the cylinder. While the interchange of heat causes some change in the amount of water in the cylinder as the piston proceeds on its course, by far the larger part of the initial condensation continues in the cylinder until the exhaust port is open, when it flashes into steam and disappears with the exhaust. While the process is a complicated one, and cannot within the limits of the present paper be accurately defined, the fact is that any change in the form of any line bounding an indicator card has its effect upon the amount of steam which must be admitted to make up the loss due to initial condensation. A change in the cycle remote from the period of admission may have as pronounced an effect on the quantity of steam required as a change in the period of admission itself. There is, in fact, no way to measure performance of a steam engine but by weighing of the feed or the exhaust. Again, a further illustration of the fact that the mere increase in the area of an indicator card is not significant, is to be found in the ease with which such increase of area may be secured. In locomotive practice it is quite unnecessary to adopt a new gear. If, under the conditions prescribed, the normal card (see engraving) is not large enough for the work, the reverse lever may be advanced on its quadrant until the cut-off is 35 per cent. of the stroke instead of 20, whereupon, in this particular case the normal card becomes equal in size with the card representing an assumed improved gear. The real question, therefore, may generally be stated as follows: Is the improved card at 20 per cent. a better card than the normal card of equal area at 35 per cent. cut-off? Will the former yield a horse-power upon the expenditure of less steam than the latter? It is upon this latter statement that the argument rests. No device which seeks to improve the steam distribution in a locomotive can succeed which does not save steam when compared with devices now in use. In proportion as it saves steam, it both increases the efficiency of the engines and increases their maximum power, for since the boiler capacity is limited, a pound of steam saved is a pound of steam available for additional services.

Turning now to a consideration of the margin upon which

those who would improve valve gears have to work, it must be admitted that it is not large. Results have already been quoted which prove that the locomotive with all its wire drawing, gives a horse power on less than 24 lbs. of steam per hour. This is near the minimum. From this performance of a simple locomotive having normal valve gear with its narrow port openings and wire drawing effects, we may turn to the Corliss engine, the action of which is generally accepted by all improvers of locomotive valve gears as a standard of perfection. Such an engine, with its large port opening, its prompt movement of the valves, can in fact be relied upon to give as good a performance as engines having any other type of valve gear operating under similar conditions of speed and pressure. Corliss engines having cylinders which are comparable in size with those of locomotives and which when under a similar range of pressure are, however, not common, and hence, it is not easy to command data for the proposed comparison. Generally simple Corliss engines work under a lower pressure than locomotives. The best performance of which I have been able to find record of a simple Corliss engine exhausting into the atmosphere is that of an 18 x 48 Harris-Corliss engine, for which the steam consumption was 23.9 lbs. per hour. The steam pressure supplied this engine was only 96 lbs. by a gauge. On the basis given the engine should, when supplied with steam at 180 lbs., which is the pressure



under which the locomotive data were obtained, require less than 23 lbs. of steam per horse-power per hour. Straining the facts applying to the two classes of engines as widely apart as a knowledge of existing data will possibly permit, we may assume that a Corliss engine, if given the advantages of the high steam pressure and high piston speed common in locomotive service may give a horse-power hour, or approximately 8 per cent. less on the consumption and 2 lbs. less of steam than the locomotive. This, then, is the margin upon which those who seek to improve the locomotive valve gear must expect to work. While it is well worth attention, it cannot revolutionize practice.

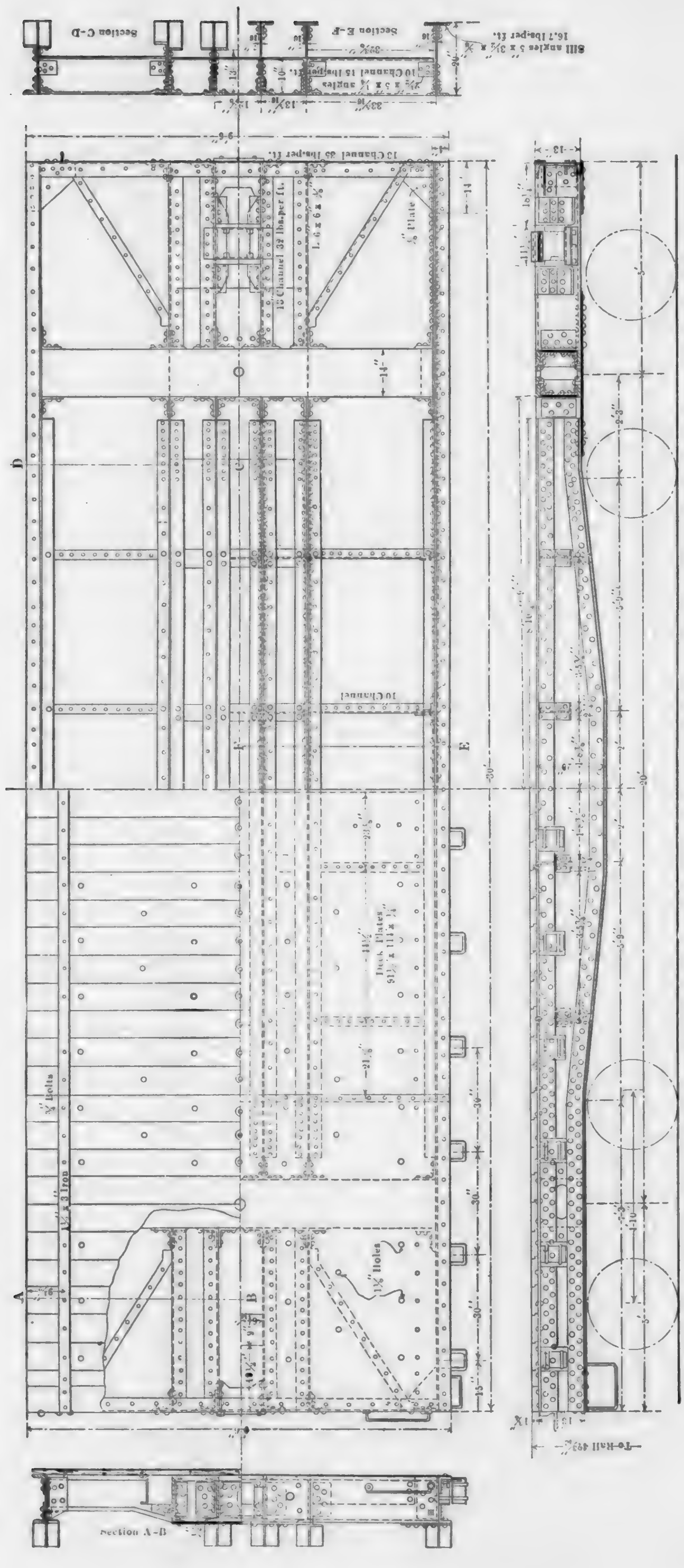
I am aware that this statement is in conflict with the experiences of many men who, having been interested in special gear, have found them to be 10, 20 and even 30 per cent. more efficient than the link motion they have displaced. A careful examination of such cases, however, will not fail to disclose the fact that the normal gear, which is made the basis of comparison, was either poorly designed, or in poor condition, and hence the results are misleading. Obviously, where two systems are involved, comparison should be based upon the best type which can be selected of each.

Valve Setting.—While somewhat apart from the purpose of my discussion, I cannot refrain from making brief reference to the matter of valve setting, for which the engraving furnishes a most admirable text. Experience both upon the testing plant and upon the road has shown that in setting valves care should be taken to avoid excessive lead at running cut-offs. Whenever the setting is such as to give a loop in the top of the card such as that which appears in the cards of the left hand column, it is safe to conclude that there is too much lead. Its reduction will increase the economy with which the engine will work at the cut-off in question. Experience also has shown that it is profitable so to reduce the lead as to avoid the loop at running cut-offs, even though there is negative lead for the longer valve travels. An examination of the cards is of interest in this connection. The cards at 15 per cent. cut-off already referred to, present too much lead, but the cut-off in question is really shorter than that at which any locomotive should be operated, and if it be assumed that these cards represent conditions which, is not impracticable, are undesirable, which is the fact, the next column of cards at 20 per cent. cut-off may be accepted as those of shortest cut-off. Here the loop has disappeared and the form of these cards may be accepted as that which attends a satisfactory degree of efficiency. With the valves thus set, it is interesting to note that at the longest cut-off of the series, namely, that of 35 per cent. stroke the lead is insufficient to sharpen the initial corner of the card, which, upon the diagram appears rounded. This, however, should create no concern, since the cards which are here presented, were obtained under conditions which have been proven to be highly efficient.—*From a paper read before the Southern and Southwestern Railway Club.*

PAPER AND PAINT FOR STEEL WORK.

An interesting experiment in the use of paraffin paper and paint to protect steel work has been going on for some time at the Jersey City station of the Pennsylvania Railroad. At the recent meeting of the American Society for Testing Materials Mr. L. H. Barker presented interesting details of this investigation. The steel work was first carefully cleaned by wire brushes and a certain kind of tacky paint was applied. The paper was then tightly pressed upon the painted surface with slightly lapping joints. Over the paper the second coat of paint may be immediately applied without waiting for the inside coat to dry. A great saving is effected by this method by necessitating but one scaffolding. The experiments have extended over three years, and are considered of too short duration to determine the value of the paper as a protection for iron and steel. They have, however, shown very satisfactory results thus far. Mr. Barker believes that the experiments prove the fact that in the case of smoke and gases corrosion begins from beneath the paint, and not from in front by the disintegration of the paint. The paper apparently prevents the access of water to the metal, and Dr. Dudley's careful experiments have shown that all paints seem to be pervious to moisture. After two years and three months exposure to smoke and gases the paper and the first adhesive coat were intact, and in places where the paper was removed for examination the adhesive coat was not yet dry, and the surface of the steel was the same as when first painted.

STEAM TURBINES IN MARINE SERVICE.—Mr. William Gray, in a paper before the Institution of Naval Architects (England), records interesting results of trials of the Midland Railway turbine steamers as compared with exactly similar ships driven by reciprocating engines. For a speed of 19.5 knots the turbine steamer saved 9.4 per cent. of coal, and at other trials the same turbine steamer saved 8.5 per cent. of coal over other vessels with reciprocating engines at a speed of 19.3 knots. Mr. Gray says: "Speaking generally, therefore, the performance of the turbine steamers, specially the 'Manxman,' have been greatly superior to those of the steamers fitted with reciprocating engines." Mr. Gray believes that the only real inferiority of the turbine vessels, which lies in the difficulty of manœuvring in narrow channels, can be overcome by increasing the backing power by making the reversing turbines more powerful. He shows the difference in the weight of machinery to be about 6 per cent. in favor of the turbines, and the difference in initial cost of the turbines as compared with the reciprocating engines 1½ per cent. of the total cost of hull and machinery.



75-TON STEEL FLAT CAR—PITTSBURGH & LAKE ERIE RAILROAD.

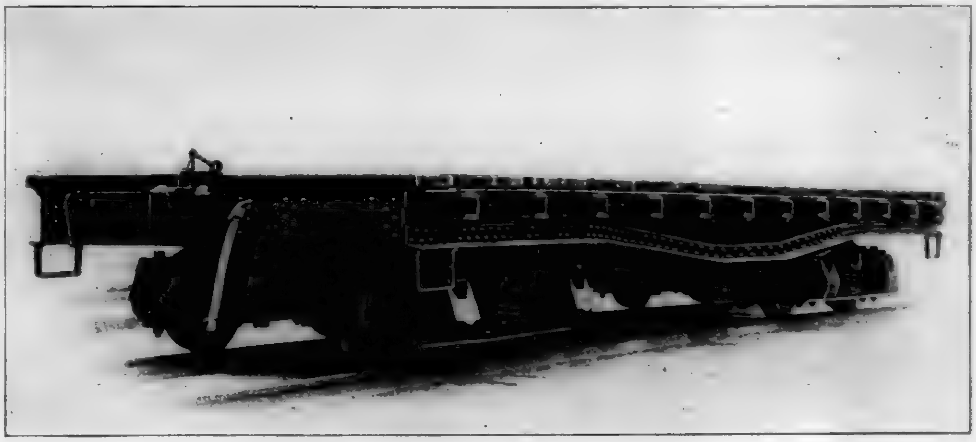
75-TON STEEL FLAT CAR.

PITTSBURGH & LAKE ERIE RAILROAD.

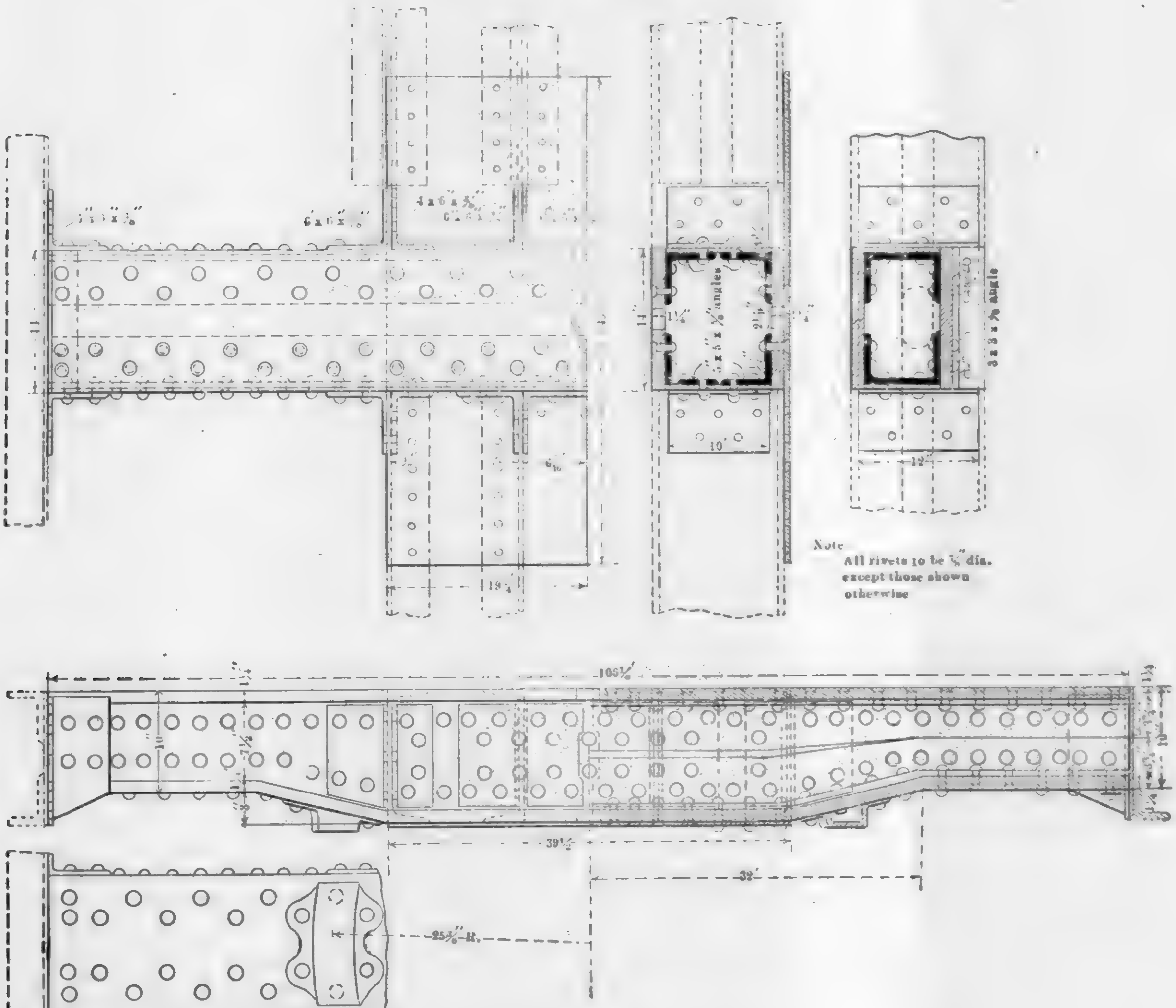
The Pittsburgh & Lake Erie Railroad has recently built at its McKees Rocks shops two 150,000-lb. capacity flat cars, which were especially designed for carrying heavy and large irregular-shaped castings. The makers and users of large castings in the Pittsburgh district were asked to furnish dimensions and weights of their largest castings, and an examination showed that the car might have to carry the greater part of the load distributed over a comparatively small space near its center, and that because of the size of some of the castings and the clearances to be observed the distance from the top of the rail to the top of the floor would have to be about 42 ins. While the car is nominally of 150,000 lbs. capacity, it is designed to carry this weight distributed over a distance of four feet at its center, and will, of course, carry safely a much greater load if distributed over a greater area. Several radical departures from ordinary steel car design will be noted. The construction is necessarily very heavy, and this is especially true of the bolsters, because of their restricted height. The light weight of the car is 48,200 lbs.

The car is 30 ft. long, 9 ft. 6 ins. wide, and the distance between truck centers is 20 ft. The body bolsters are continuous. The center and intermediate sills between the bolsters are built up of 7-16-in. plate, with two 5 x 3½ x ⅝-in angles, riveted at both the top and bottom, forming a beam of I section. The side sills are of the same construction, except that the 7-16-in. plate and the two outside angles extend the full length of the car, as shown in the drawings. The sills are 20 ins. deep for a distance of 4 ft. at the middle of the car, and taper to 13 ins. at the bolsters. The center and intermediate sills are tied together at intervals of about 4 ft. by malleable iron filling blocks, while the intermediate and side sills are tied by 10-in. channel irons. The intermediate and center sill extensions beyond the bolsters are 13-in. channels. The end sill is a 13-in. channel, and it is securely braced at its ends by the 8-in. channel braces which extend from the intermediate sills and by the ⅜-in. gusset plates at the corners of the car. The ¼-in. deck plates which cover the entire car, and are riveted to the sills, bolsters and cross-braces, add greatly to its strength and stiffness.

The body bolster is of box section, built up of plates and angles. The top and bottom members are of 1¼ x 14-in. iron, while the side plates are ½ in. thick. The four angles are 5 x 5 x



75-TON STEEL FLAT CAR.

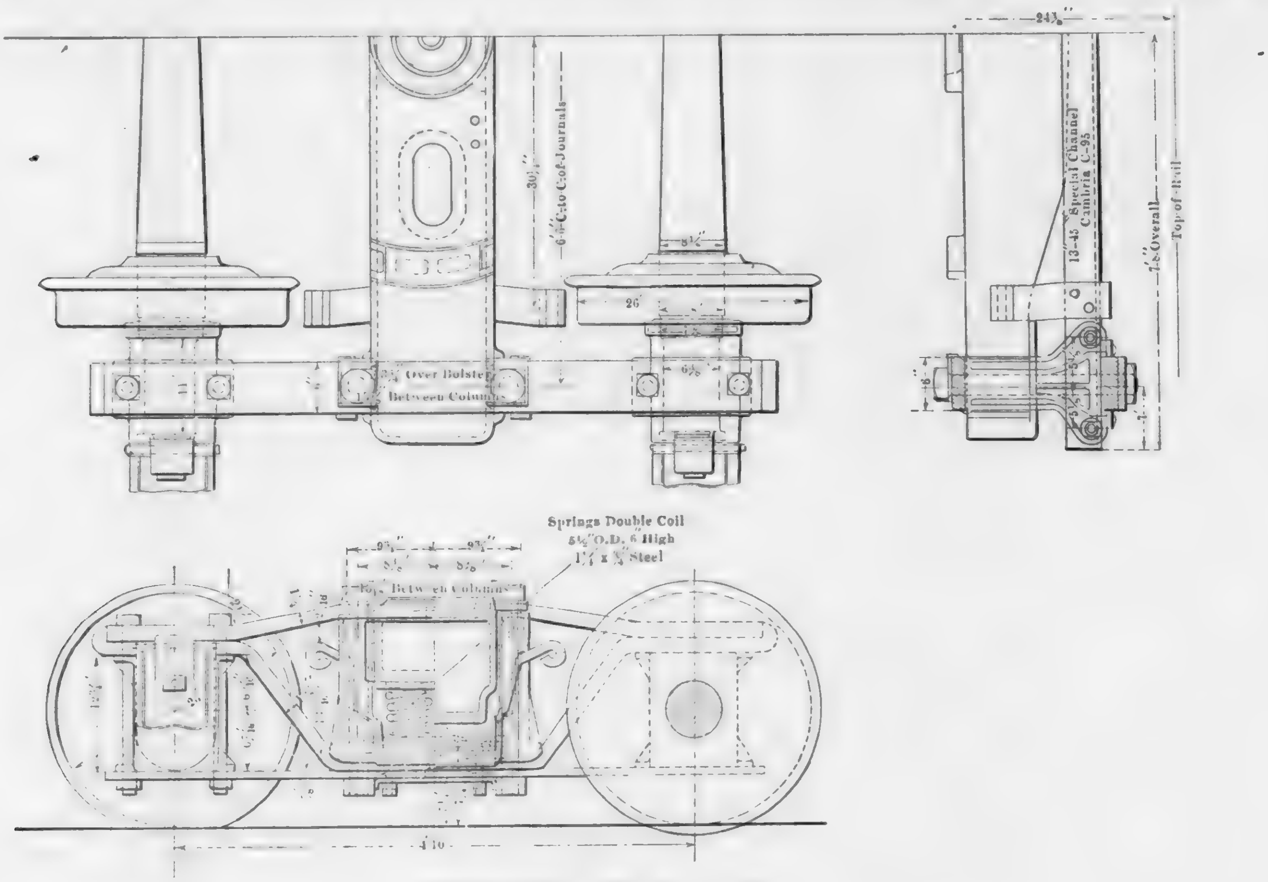


BODY BOLSTER—75-TON STEEL FLAT CAR.

⅝ ins. The bolsters are 13 ins. deep at the center and 10 ins. at the ends. The webs of the sills are securely attached to the bolsters by the heavy angles, while the flanges of the sills are riveted to the ¼-in. deck plates and the ½-in. cover plates at the bottom of the bolsters.

A 1¾-in. plank floor covers the steel plates, and is held in place by the ½ x 3-in. iron straps. The 1⅛-in. holes through the floor are for bolts or straps to hold the blocking and castings in place.

The truck is of the arch bar type, and is notable because of its heavy construction. The top arch bars are 1¾ x 6 ins., the lower ones 1⅝ x 6 ins., and the tie plates are ⅞ x 6 ins. Steel-tired wheels, 26 ins. in diameter, are used because of the low height of the car and the fact that it is necessary to reduce the truck wheel base to a minimum in order to secure the necessary strength. The truck journals are 6⅜ x 11 ins. The bolsters are of cast steel, and were designed and made by the American Steel Foundries Company. A nest of four double coil springs, 5½ ins. in diameter and 6 ins. high, supports the bolster at each end. The lower center plate and side bearings are cast integral with the bolster. The distance from the top of the rail to the top of the truck bolster is only 24⅜ ins. We are indebted for information and drawings to Mr. L. H. Turner, superintendent of motive power, and Mr. W. P. Richardson, mechanical engineer.



TRUCK—75-TON STEEL FLAT CAR.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

VIII.

(For previous article see page 219.)

The grey iron foundry is 122 by 342 ft., and is located near the locomotive shop, with one end against the midway. This building provides a central floor with a crane span of 57 ft., served by a 10-ton crane. The central portion has a clear height of 29 ft. under the roof trusses, and the lower faces of the crane runways are 20 ft. above the floor. The two wings are 30 ft. wide and 16 ft. high. As shown in the plan, one wing provides for a chipping and tumbler room, an office, pattern storage, rooms for blowers, sand and facing; and the other for the cupolas, four core ovens and core room, and a large space for the flask maker. The cupola room has a second story with a heavily constructed platform, which constitutes the charging floor. This floor is extended into the yard, a distance of 14 ft. 6 ins., connecting with a platform upon which the out-of-door crane delivers pig iron and coke. This yard crane has a span of 60 ft. and reaches the stock piles. The engravings show the plan of the foundry, and section and the plan of the charging room. This building provides a total ground area of 42,475 sq. ft., and has a capacity for 50 tons daily. One of the engravings illustrates the interior of the building, showing the central portion, where the heavy work is done. This view was taken looking toward the midway. It shows two of the core ovens at the left. A monitor with a glass roof extends the full length of the building, and in addition to this an upper row of windows over the crane runways gives an unusual amount of light for a foundry. The ultimate capacity of this foundry is to be 75 tons per day.

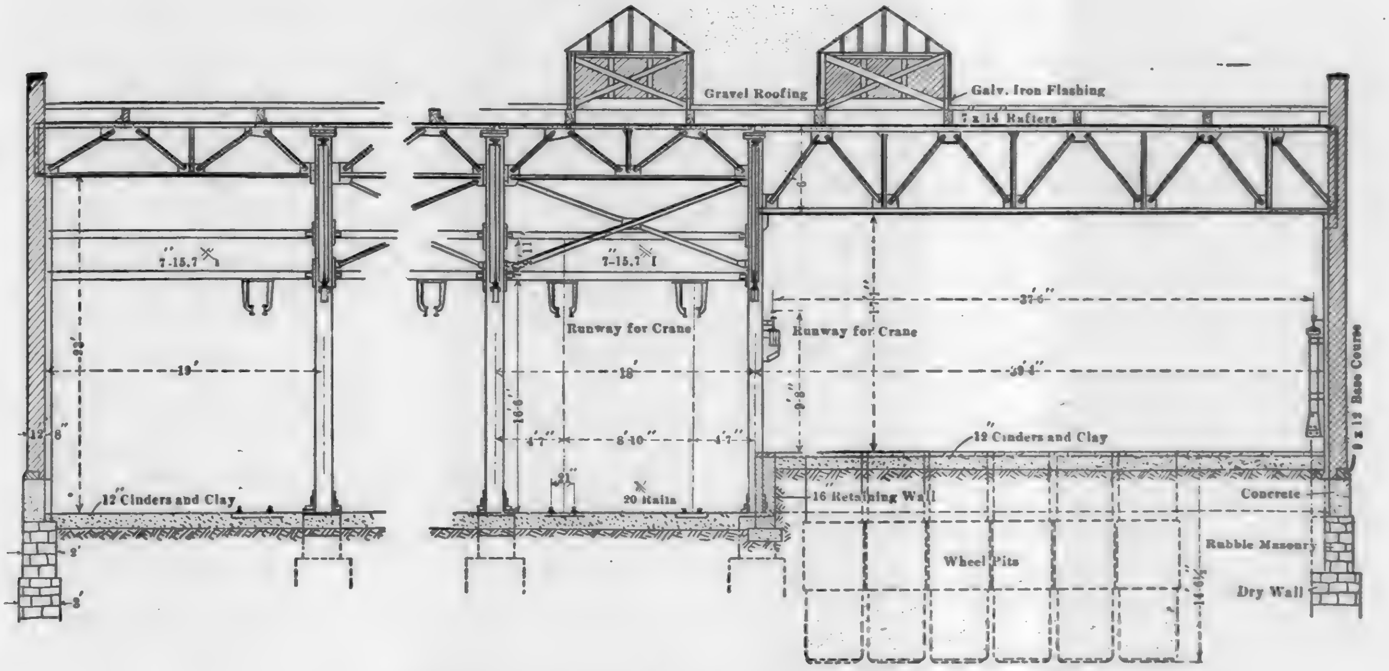
GREY IRON FOUNDRY EQUIPMENT.

No. 9½ Whiting cupola.
No. 7 Whiting cupola.
No. 7 Root blower.
Two truck ladles for slag; capacity, 1,500 lbs.
One 9 by 14 by 8 ft. 6 ins. core oven.
Three 9 by 18 by 8 ft. 6 ins. core ovens.
Four core oven cars, 6 by 8 ft.
Four core oven cars, 5 by 6 ft.
Twelve charging cars, 3 tons capacity, 24 ins. gauge.
Two 48-in. turn-tables for charging platform.
Two dump buckets, 4 ft. 6 ins. diameter by 4 ft. deep for yard crane.
One 3-motor travelling crane, 10 tons capacity, for foundry.
One 3-motor crane, 10 tons capacity, for yard.
One 2-motor 3-ton crane, for core room.

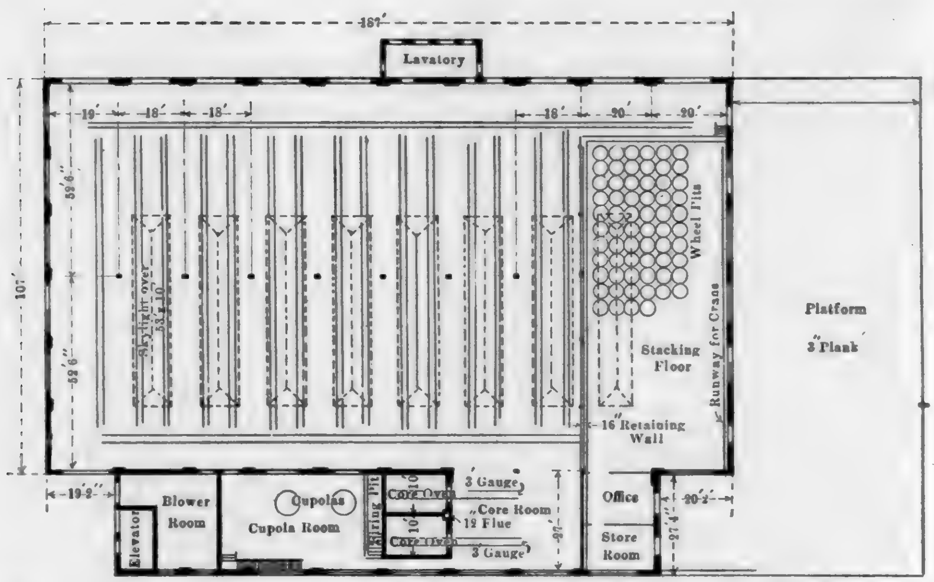
WHEEL FOUNDRY.—This foundry is conveniently arranged and located near the freight car and truck shops. It is 107 by 187 ft. in size, and divided into three transverse sections. The cupolas are in a room 90 ft. long by 27 ft. wide, with the charging floor above. This building covers an area of 24,516 sq. ft. At one end the annealing pits and storage spaces are provided for with a floor 4 ft. above that of the molding floor. From this a 1½-ton electric crane, with a span of 37 ft. 6 ins., covers the entire area. The molds are placed in transverse rows with a travelling hoist over each row, and at the end of the rows of molds narrow-gauge tracks carry the ladles from the cupola. This foundry was built for a capacity of 300 wheels per day, which are poured on fifteen floors of twenty wheels each. Two cupolas are provided for use alternately. The hot wheel cars are arranged in a train of four to receive the wheels at the lower end of the floors when transported by the transverse travellers. The wheel breaker and stock are in the rear of the building, convenient to the elevator reaching the charging floor. The line engravings show a longitudinal section and plan and the interior view of this foundry. A small detail drawing shows the runway hangers for the carriers and molding floors.

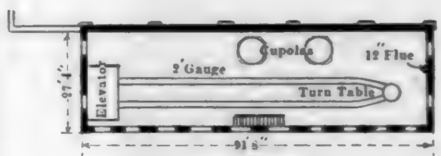
EQUIPMENT FOR THE CAR WHEEL FOUNDRY.

Fifteen belted floor carriers.
Two 8-ton reservoir ladles, with D. C. motor and controller.
Four ladle trucks making a train.
One puller machine for ladle transfer.
Ten pouring ladles, 800 lbs. capacity.
One puller machine for wheel transfer, D. C. motor and controller.
Four wheel trucks, a continuous train.

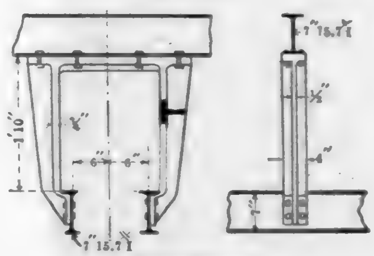


LONGITUDINAL SECTION THROUGH WHEEL FOUNDRY.



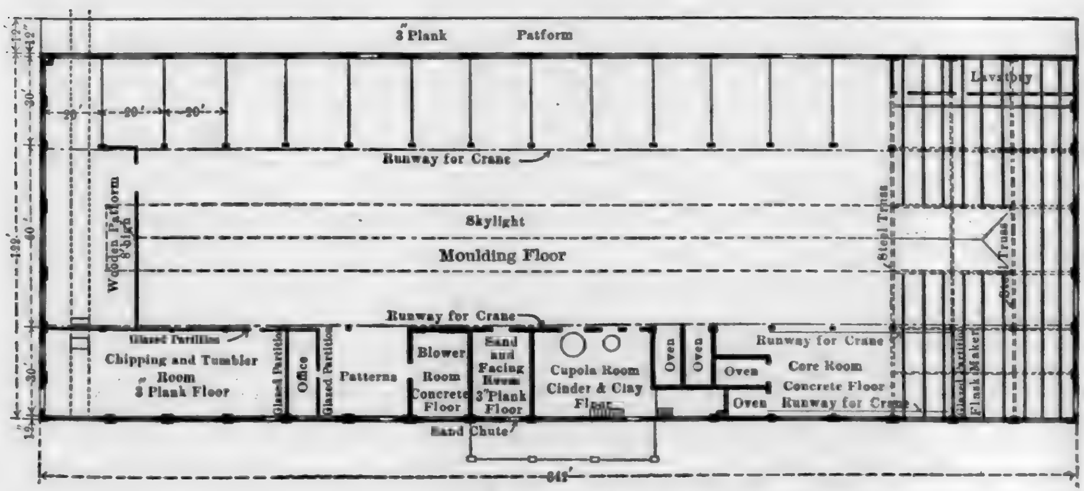


Charging Floor

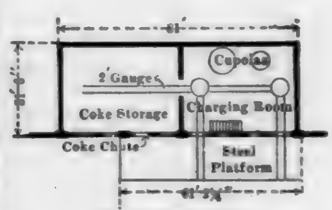


Runway Hanger

FLOOR PLAN OF WHEEL FOUNDRY.

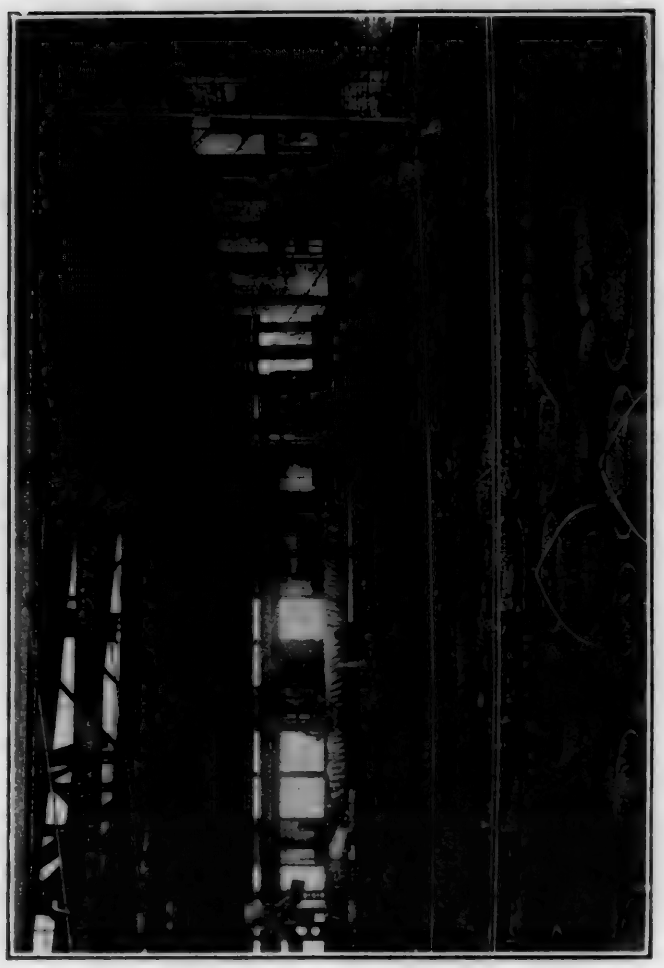


GROUND PLAN OF GREY IRON FOUNDRY.

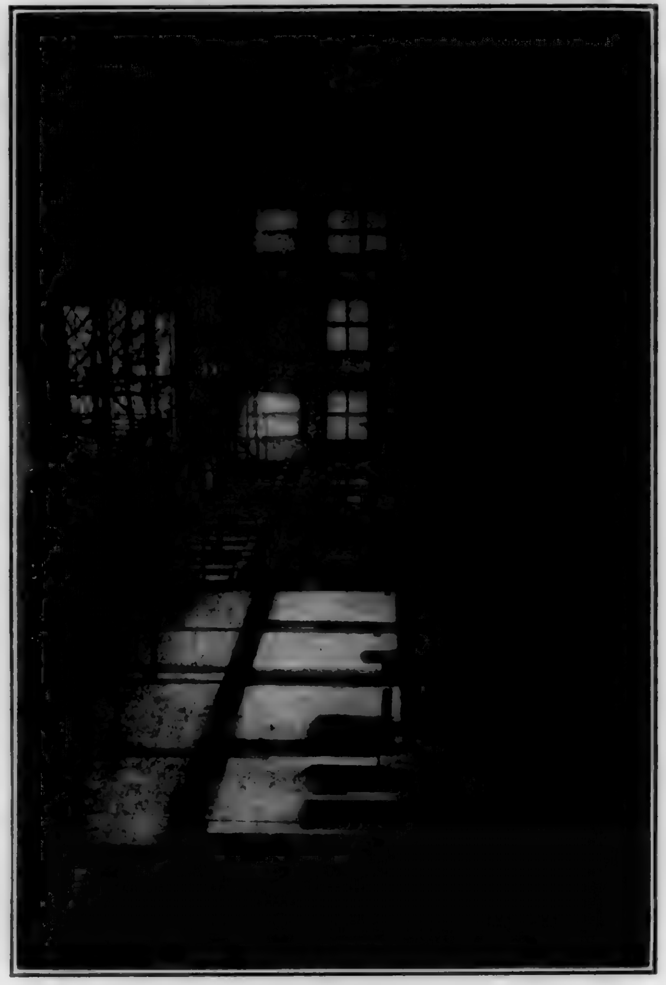


Plan of Charging Floor

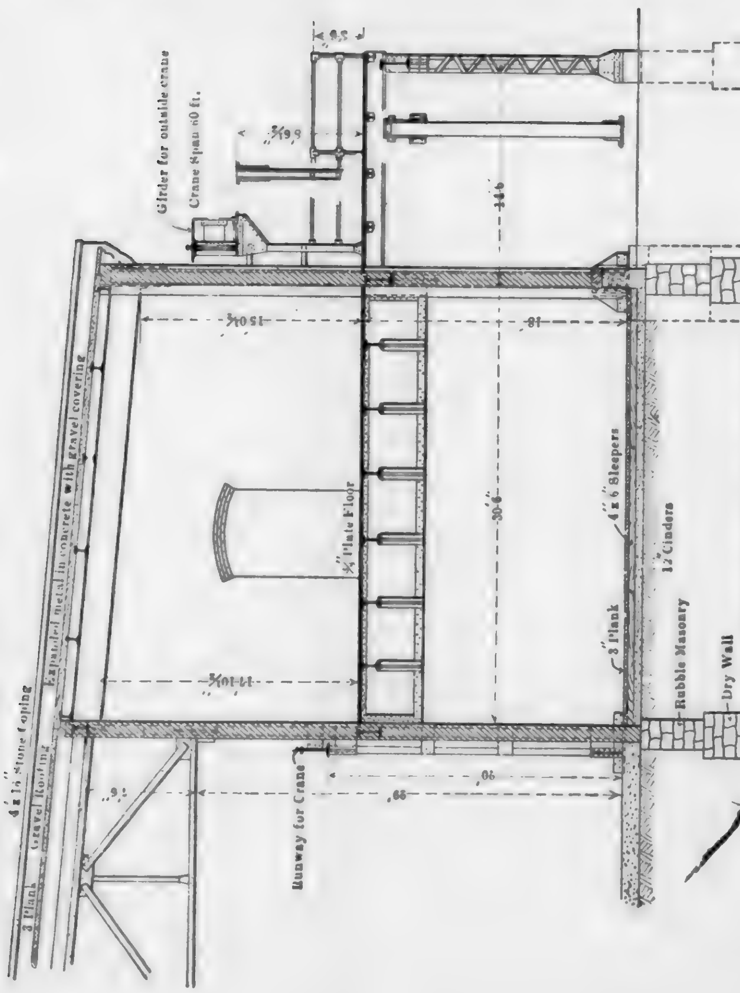
GREY IRON AND WHEEL FOUNDRIES, ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.



GENERAL VIEW IN WHEEL FOUNDRY.



GENERAL VIEW IN GREY IRON FOUNDRY.



CROSS-SECTION OF GREY IRON FOUNDRY.

One 3-motor D. C. electric pitting crane.
Sixty-four annealing pits for 20 wheels each.
No. 9½ Whiting cupola.
Two core ovens, 9 by 15 ft.
Four core oven cars.
No. 7 Root blower, direct connected with D. C. motor.
Ten 48-in. turn-tables.
Twenty 3-ton trucks.
Pneumatic wheel breaker.
One double cage 3-ton electric elevator.

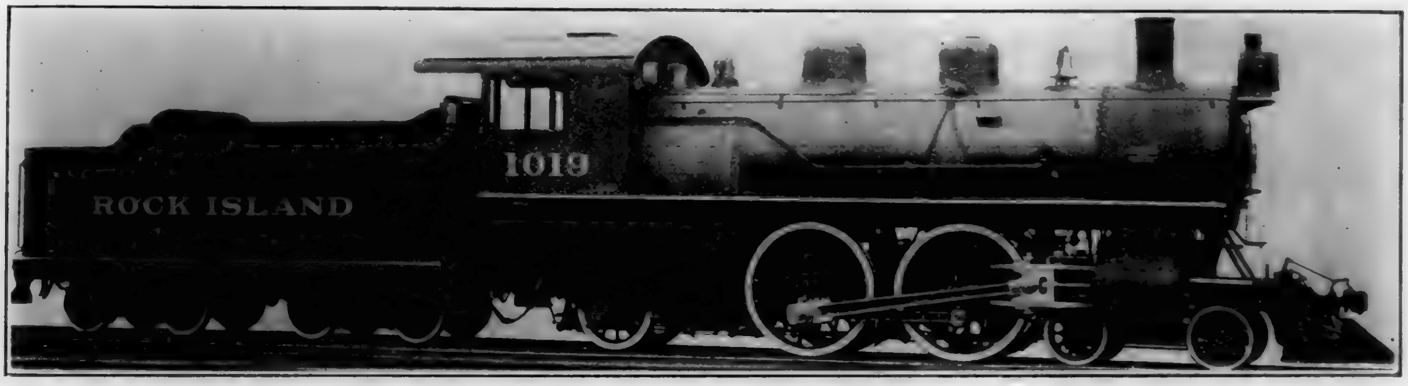
The floor cranes are of 1,500 lbs. capacity, running upon tracks 106 ft. long. A line shaft furnishes power for the hoisting machine, the gearing of which is operated by straight and cross belts, the travellers being fitted with ½-in. wire rope. The lift is 12 ft. The travelling gearing is located nea the hoisting gearing, and attached to the trusses, the mechanism being reversible, consisting of friction gearing, driving and curved face friction drums, which carry the endless pullin rope attached to the trolley. The reverse movements of th trolley are obtained by setting the friction wheel again either of two friction pulleys. The trolleys have cast iro frames and run on I beam tracks, as shown in the engraving. The ladle trucks have structural steel frames larg enough for two 800-lb. ladles. These trucks are connecte together to form a continuous train, and are used for carrying molten metal across the front of the floor. This train is operated by a puller machine, which is driven by a moto The wheel trucks have cast steel frames, arranged to receiv the hot wheels in an inclined position from the floor crane. The pitting crane is fitted with a special trolley, having two hoisting blocks and arranged to handle two wheels at a time The annealing pits are of tank steel, with 3-16-in. sides and heads. Equipment for this foundry was furnished by th Whiting Foundry Equipment Company, Harvey, Ill.

ATLANTIC TYPE PASSENGER LOCOMOTIVE, WITH SUPERHEATER.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

The proposed standard locomotives recommended by the power committee of the Rock Island System were presented in outline in this journal in March of this year, page 84. On page 282 of the August number the Pacific type passenger locomotive was illustrated.

Ten Atlantic type passenger locomotives have been built by the Schenectady works of the American Locomotive Company, one of which is shown in the accompanying photograph. Two of these are equipped with Cole superheaters. These locomotives are for fast passenger service, and are similar to earlier ones which have been running very successfully on the Chicago & Eastern Illinois. After the completion of certain grade reductions the present driving wheels may be replaced by 79-in. wheels. These locomotives have 12-in. piston valves, straight boilers, deep fireboxes and rigid trailer trucks with outside journals. The superheater has a heating surface of 338 sq. ft. in 54 3½-in. tubes. The leading dimensions are as follows:



ATLANTIC TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

ATLANTIC TYPE PASSENGER LOCOMOTIVE WITH SUPERHEATER.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	24,700 lbs.
Weight in working order	185,000 lbs.
Weight on drivers	104,100 lbs.
Weight of engine and tender in working order	323,850 lbs.
Wheel base, driving	7 ft.
Wheel base, total	27 ft. 5½ ins.
Wheel base, engine and tender	57 ft. 1½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.2
Tractive effort x diam. drivers ÷ heating surface	754
Heating surface ÷ grate area	53.3
Total weight ÷ tractive effort	7.49
CYLINDERS.	
Kind	Simple, piston valve.
Diameter and stroke	21 by 26 ins.
Piston rod, diameter	3¾ ins.
VALVES.	
Kind	Piston.
Greatest travel	6 ins.
Outside lap	1 in.
Lead	¼ in. at ¼ stroke.
WHEELS.	
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3¼ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Straight top.
Working pressure	185 lbs.
Outside diameter of first ring	72 ins.
Firebox, length and width	96 by 67 ins.
Firebox plates, thickness	⅜ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	173, 2-in.; 54, 3½-in.
Tubes, gauge and length	11, 16 ft. long.
Heating surface, tubes	2,227 sq. ft.
Heating surface, firebox	162 sq. ft.
Heating surface, total	2,389 sq. ft.
Superheater heating surface	338 sq. ft.
Grate area	44.8 sq. ft.
Exhaust pipe	Single, 5⅛ ins.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 1½ ins.
Centre of boiler above rail	108 ins.
TENDER.	
Tank	Water bottom.
Frame	13-in. channels.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.

COST OF POWER.

The following figures are taken from a paper on "Gas as a Motive Power and Its Relative Cost," read before the Canadian Society of Civil Engineers by Mr. W. H. Laurie. Considering the cost of fuel only, the relative cost per brake horse-power per annum of power developed by gasolene, steam and gas engines is as follows:

Gasoline engine	78.00
Illuminating gas with modern gas engine	46.80
Steam engine	37.44
Semi-water gas from anthracite coal	7.80
Semi-water gas from gas coke	5.74
Water and producer gas (bituminous coal)	5.00

These figures are based upon the following assumptions: A year is taken as 312 days of 10 hours each; one-eighth of a gallon of gasolene is required per b.h.p hour at 20 cents per gallon; an average of 15 cu. ft. of illuminating gas is required per b.h.p. hour at $1 per 1,000 cu. ft.; an average of six pounds of coal is required per b.h.p. hour with automatic high pressure steam engines of small powers with coal at $4 per ton; semi-water gas from anthracite coal will develop a b.h.p. on one pound of coal in the generator with coal at $5 per ton; semi-water gas from gas coke will develop a b.h.p. hour on .92 lbs. of coke at $4 per ton; water gas with plants of 500 h.p., and over will produce a b.h.p. on .80 lbs. of bituminous coal at $4 per ton. The water gas system is especially adapted for large power plants and except under special conditions is of greater capacity than required for small units.

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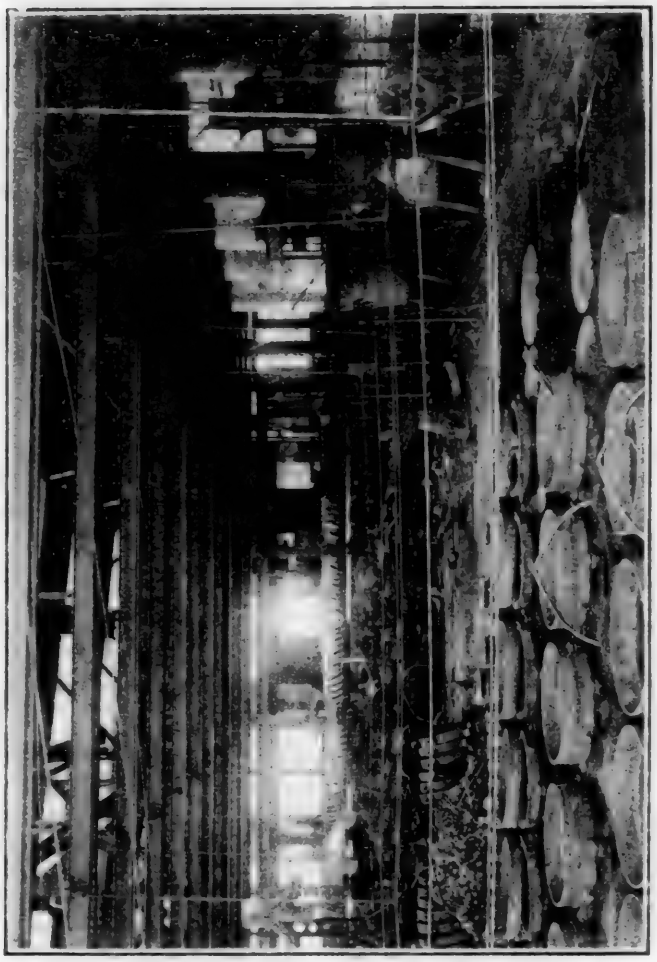
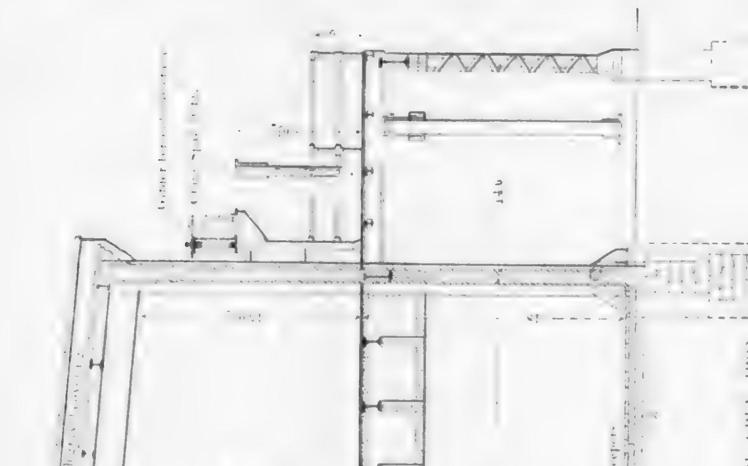


GENERAL VIEW IN WHEEL FOUNDRY.

GENERAL VIEW IN GRAY IRON FOUNDRY.



CROSS-SECTION OF GRAY IRON FOUNDRY.

One 3-motor D. C. electric pitting crane.
Sixty-four annealing pits for 20 wheels each.
No. $9\frac{1}{2}$ Whiting cupola.
Two core ovens, 9 by 15 ft.
Four core oven cars.
No. 7 Root blower, direct connected with D. C. motor.
Ten 48-in. turn-tables.
Twenty 3-ton trucks.
Pneumatic wheel breaker.
One double cage 3-ton electric elevator.

The floor cranes are of 1,500 lbs. capacity, running u[illegible] tracks 106 ft. long. A line shaft furnishes power for [illegible] hoisting machine, the gearing of which is operated by strai[illegible] and cross belts, the travellers being fitted with $\frac{1}{2}$-in. w[illegible] rope. The lift is 12 ft. The travelling gearing is located n[illegible] the hoisting gearing, and attached to the trusses, the mech[illegible]ism being reversible, consisting of friction gearing, driving [illegible] curved face friction drums, which carry the endless pull[illegible] rope attached to the trolley. The reverse movements of [illegible] trolley are obtained by setting the friction wheel agai[illegible] either of two friction pulleys. The trolleys have cast ir[illegible] frames and run on I beam tracks, as shown in the engra[illegible]ing. The ladle trucks have structural steel frames la[illegible] enough for two 800-lb. ladles. These trucks are connect[illegible] together to form a continuous train, and are used for carr[illegible]ing molten metal across the front of the floor. This train [illegible] operated by a puller machine, which is driven by a mot[illegible] The wheel trucks have cast steel frames, arranged to recei[illegible] the hot wheels in an inclined position from the floor cran[illegible] The pitting crane is fitted with a special trolley, having tw[illegible] hoisting blocks and arranged to handle two wheels at a tim[illegible] The annealing pits are of tank steel, with 3-16-in. sides a[illegible] heads. Equipment for this foundry was furnished by t[illegible] Whiting Foundry Equipment Company, Harvey, Ill.

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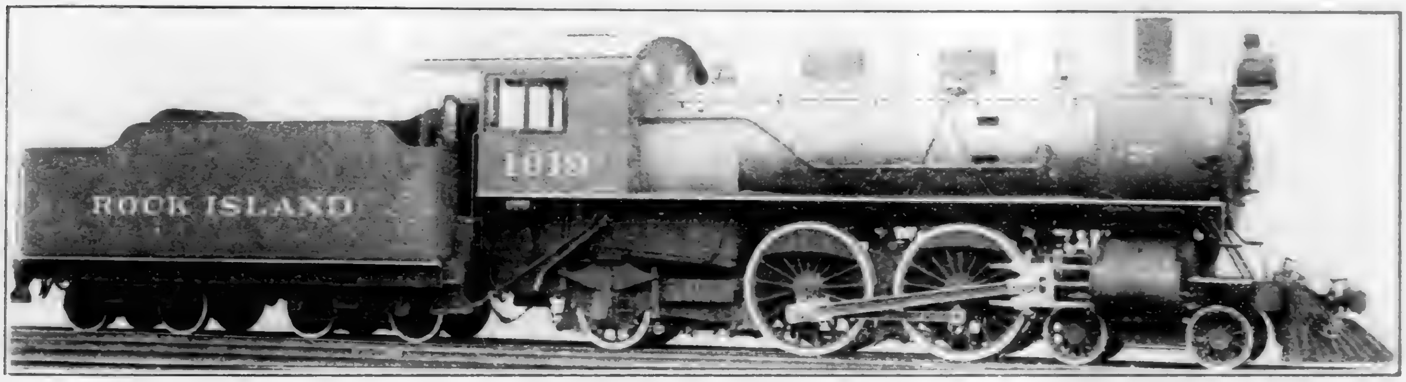

ATLANTIC TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

ATLANTIC TYPE PASSENGER LOCOMOTIVE WITH SUPERHEATER.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal
Tractive power	24,700 lb.
Weight in working order	185,000 lbs.
Weight on drivers	104,100 lbs.
Weight of engine and tender in working order	323,850 lbs.
Wheel base, driving	7 ft.
Wheel base, total	27 ft. 5½ ins.
Wheel base, engine and tender	57 ft. 1½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.2
Tractive effort x diam. drivers ÷ heating surface	751
Heating surface ÷ grate area	53.3
Total weight ÷ tractive effort	7.49
CYLINDERS.	
Kind	Simple, piston valve.
Diameter and stroke	21 by 26 ins.
Piston rod, diameter	3⅝ ins.
VALVES.	
Kind	Piston.
Greatest travel	6 ins.
Outside lap	1 in.
Lead	¼ in. at ¼ stroke
WHEELS.	
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Straight top.
Working pressure	185 lbs.
Outside diameter of first ring	72 ins.
Firebox, length and width	96 by 67 ins.
Firebox plates, thickness	⅜ and 9/16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	173, 2-in.; 54, 3½-in.
Tubes, gauge and length	11, 16 ft. long.
Heating surface, tubes	2,227 sq. ft.
Heating surface, firebox	162 sq. ft.
Heating surface, total	2,389 sq. ft.
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Grate area	44.8 sq. ft.
Exhaust pipe	Single, 5⅛ ins.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 1½ ins.
Centre of boiler above rail	108 ins.
TENDER.	
Tank	Water bottom
Frame	13-in. channels
Wheels, diameter	36 ins.
Journals, diameter and length	[illegible] by 16 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons

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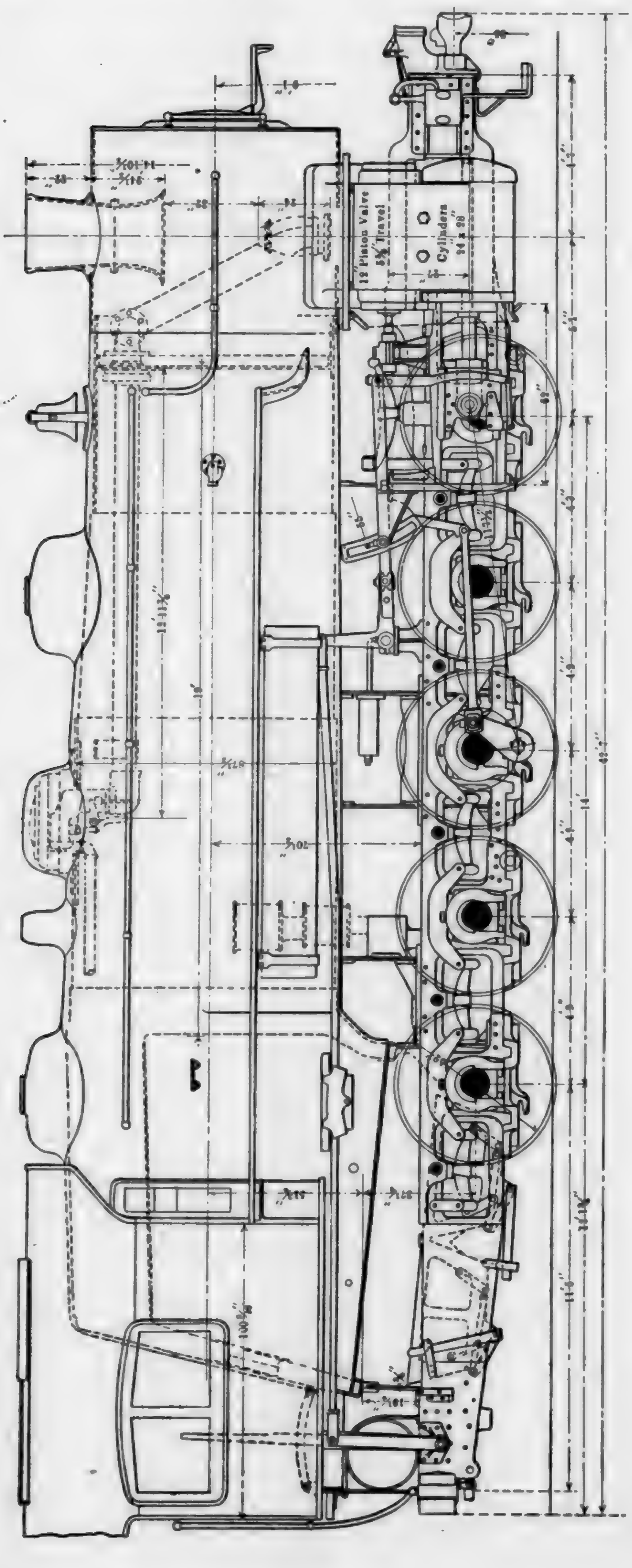
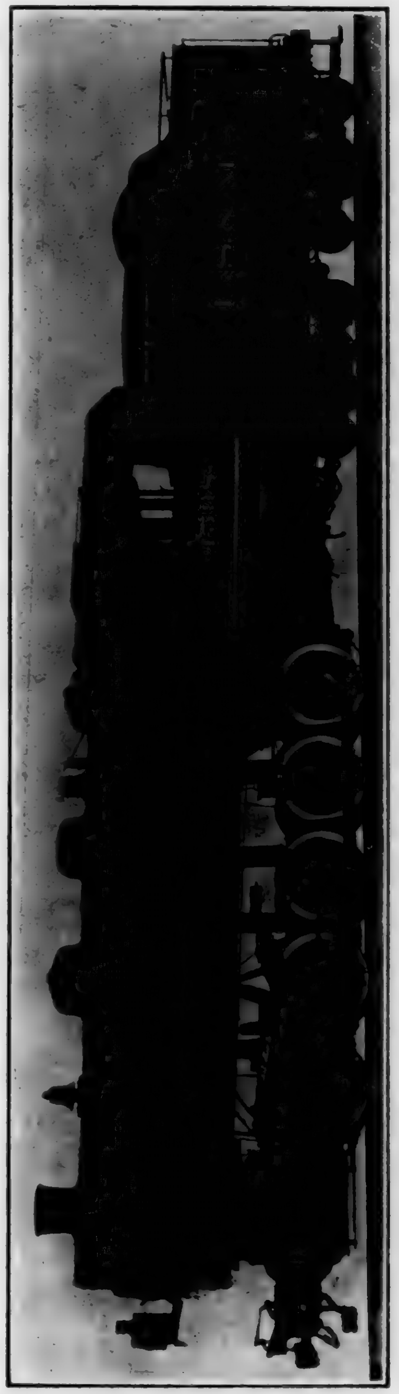
HEAVY SWITCHING LOCOMOTIVE.

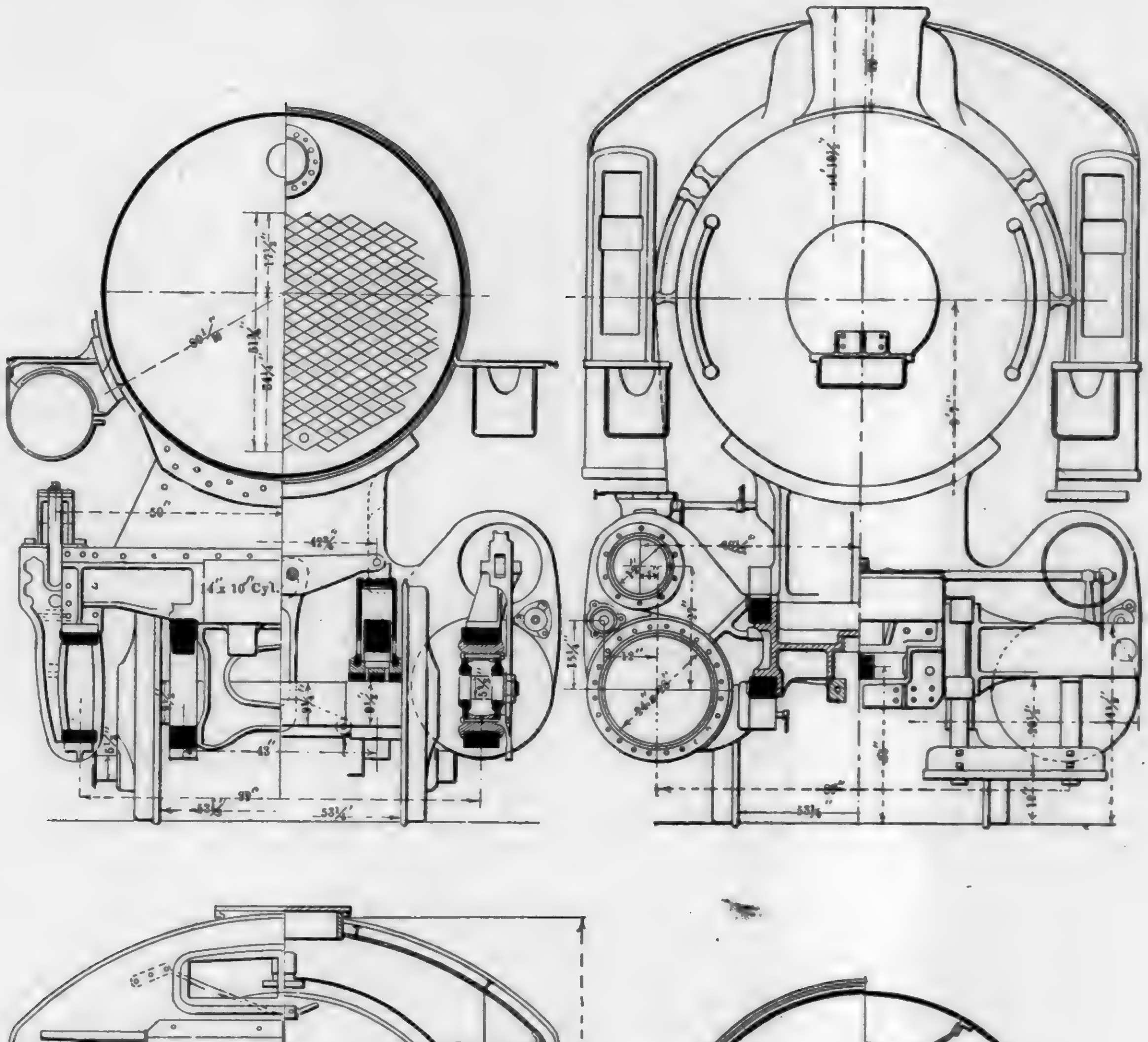
NEW YORK CENTRAL LINES.

For hump yard service on the Lake Shore two ordinary locomotives have been required to handle trains over the summits in switching. To provide in a single engine the great tractive power required for this work the American Locomotive Company has built, at the Brooks Works, a number of the heaviest and most powerful switching locomotives ever constructed. Two of these are used in the hump yard at Elkhart, two at Collinwood and one is used in pusher service on the grade westbound out of Cleveland. The grades in the hump yards are from 0.67 to 2.00 per cent., and the grade out of Cleveland is 39 ft. per mile. One of these locomotives is intended to handle as heavy a train as can be hauled into the yard by the heaviest road engines. With a tractive effort of 55,300 lbs., a total weight of 270,000 lbs., cylinders 24 x 28 ins. in diameter and a total heating surface of 4,625 sq. ft., these locomotives take a high place among the largest in use. All of the weight is upon the driving wheels, which are 52 ins. in diameter, and a very large boiler is required for supplying steam to these large cylinders when working full stroke. In the matter of details, the 4¼-in. piston rods, 6-in. frames and unusually heavy bracing across the frames, are worthy of note. These locomotives are fitted with Walschaert valve gear, which was adopted in this case for convenience in accessibility. The general dimensions of the design are presented in the accompanying table:





POWERFUL SWITCHING LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



POWERFUL SWITCHING LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

HEAVY SWITCHING LOCOMOTIVE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	55,300 lbs.
Weight in working order	270,000 lbs.
Weight of engine and tender in working order	419,600 lbs.
Wheel base, driving	19 ft.
Wheel base, engine and tender	54 ft. 5½ ins.

RATIOS.

Tractive weight ÷ tractive effort	4.8
Tractive effort x diam. drivers ÷ heating surface	622
Heating surface ÷ grate area	84
Total weight ÷ tractive effort	4.8

CYLINDERS.

Kind	Simple
Diameter and stroke	24 by 28 ins.
Piston rod, diameter	4¼ ins.

VALVES.	
Kind	12-in. piston.
Greatest travel	5⅝ ins.
Outside lap	1 in.
Valve motion	Walschaert.
WHEELS.	
Driving, diameter over tires	52 ins.
Driving journals, main, diameter and length	10½ by 12 ins.
BOILER.	
Style	Radial wagon top.
Working pressure	210 lbs.
Outside diameter of first ring	80 1-16 ins.
Firebox, length and width	108 by 73 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	447, 2-in.
Tubes, gauge and length	11, 19 ft. long.
Heating surface, tubes	4,422 sq. ft.
Heating surface, firebox	203 sq. ft.
Heating surface, total	4,625 sq. ft.
Grate area	55 sq. ft.
Exhaust pipe	Single.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 10½ ins.
Centre of boiler above rail	109 ins.
TENDER.	
Tank	Water bottom.
Frame	13-in. channels.
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,000 gals.
Coal capacity	12 tons.

THE NEW PENNSYLVANIA DYNAMOMETER CAR.

By W. O. Dunbar.

The car, as a whole, is of special design throughout, and is carried on two 4-wheel trucks. The trucks are of new design, necessitated by the form of construction of the underframe of the car. The main features, however, are three, the dynamometer being on the hydraulic principle:

First—The drawbar and its attachments to the hydraulic cylinder.

Second—The weighing mechanism and transmission of the pressure to give the necessary movement of the pen, which is to indicate the amount of the pull.

Third—The paper diagram driving mechanism and the connection to the axle of the car.

In this order it may be said that the underframe of the car is completed, being made excessively strong. The central portion of it consists of a heavy steel plate box girder 21 ins. deep by 38 ins. wide, extending 51 ft., the entire length of the car, forming a practically dustproof and water-tight housing for the drawbar and its attachments.

This drawbar is to be 20½ ft. long from the front end of the coupler to the rear end of the hydraulic piston. The piston is 8 ins. long by 16¼ ins. in diameter, with piston rods at either end 6 ins. in diameter, and fits the cylinder with the greatest possible accuracy to work without friction and without packing.

The drawbar, at the coupler end, is made up with a standard automatic coupler and Westinghouse friction draft gear, as in our standard freight cars, but caged in a rectangular, boxlike steel casting, which is open at the front end only and large enough inside to allow free room for the side play of the coupler at the open end and for the cushioning action of the inclosed draft gear. This particular steel casting may be called the coupler cage. The rear end of the coupler is pivoted to the front end of the draft gear to allow the side play referred to. The rear end of the coupler cage is rigidly connected to the drawbar proper, forming a part of it.

The remaining important feature of the drawbar consists of a nest of helical buffer springs confined in a strap under a compression load of 100,000 lbs. in such a manner as to form a continuous and rigid portion of the drawbar under all pulls up to 100,000 lbs., the maximum capacity expected to be recorded by the weighing mechanism; but when a pull or push greater than 100,000 lbs. is exerted by shock or otherwise, the drawbar stretches or contracts by means of a still further compression of these springs. This is to prevent undue strain being put on the piston and cylinder, which, however, are capable of standing a much heavier load without injury.

From this it will be seen that the drawbar altogether is a pretty massive piece of apparatus. Great pains have been taken to support this drawbar, as a whole, so that for any pull or push it will move practically frictionless.

The coupler cage is supported by six circuitous groups of hardened steel balls, 32 balls in each; two groups beneath, two above and one group on either side, each group giving a bearing over a foot in length. Ten balls of each group, 60 in all, are always in supporting contact with the coupler cage. These balls are each 1¼ ins. in diameter, and so exactly guided in their races that there is no likelihood of their binding one against the other.

While the coupler has all necessary play within the cage, the cage itself is to be so neatly fitted between the groups of balls that it has practically no side play.

At the other end, as near to the piston as practicable, the drawbar is surrounded and supported by a nest of small balls in a short cylindrical case, which in turn is held in a bushing, so that the nest rolls longitudinally back and forth in its bushing and along the drawbar as the latter moves, but is prevented from creeping along the bar more than 1¼ ins. either way by the end walls of the surrounding bushing.

The drawbar is made 5 ins. in diameter for a considerable portion of its length from the point where it connects to the coupler cage to provide ample stiffness; but to further prevent any tendency to sagging, there is located between the 100,000-lb. buffer springs and the coupler cage another specially constructed bearing consisting of two rollers, each acting as a support at an angle of 60 deg. with the vertical and turned to an exact radius equal to the distance to the supporting surfaces. These two rollers are pivoted to the drawbar with roller journals and prevented from sliding by being provided with accurately cut teeth, on the outer edge, which mesh with the rack along the edge of the supporting surface.

Buckling from any shock is prevented by cylindrical bushings or guides, through which the drawbar passes without friction, and at the same time without lost motion. Moreover, when the dynamometer is not in service the coupler cage is locked by blocking specially provided, preventing any load from reaching the drawbar beyond the coupler cage.

The longitudinal motion of this cage, when not locked, is the same as that of the piston and drawbar proper, and is in the direction of the pull along the center line of the car, and for any pull under 100,000 lbs., were there no leakage, would never amount to more than .3 of an inch, but in case of shocks or leakage a total motion of 2.8 ins. (1.4 ins. either way from the central position) is allowed for. This excessive motion will be but temporary in any case, as a leakage pump is to be provided to automatically adjust the piston to its central position.

Since the coupler cage as described has no side play to speak of and so little longitudinal motion, it becomes a comparatively easy matter to completely seal the drawbar as a whole within the box girder of the underframe, to keep out dust and protect the ball bearings from rust, by simply inserting a strip of packing around the outside surface of the coupler cage between it and the closely surrounding surface of the steel casting which forms the opening in the end of the box girder through which the coupler cage protrudes.

It may be noted here that the box girder described is made deeper for a distance at the point where the piston is located, and also at the 100,000-lb. buffer springs, to provide more room for these parts and for getting at them, which will be done from manholes in the car.

The effective area of the drawbar piston is to be 181.12 sq. ins. The movement of the dynamometer pull pen at full capacity is to be 10 ins. Thus, to get the 10 ins. motion, that of the drawbar will be multiplied practically 36 times at the recording cylinder. The pull pen is attached to the end of the piston rod of the recording cylinder, which is 40 ins. long inside and 2 27-32 ins. in diameter, having the effective area of 5.032 sq. ins.

The recording piston is 26 ins. long over all, and midway of its length consists of a 2-wheel carriage 18 ins. long, which carries the weight of the piston. The two carriage wheels are of very nearly the same diameter as the piston itself, the two

ends of the piston being each 4 ins. long and the closest possible fit in the cylinder, so as to work without packing and with a minimum of leakage and friction.

The pressure is transmitted from the front or back head of the drawbar piston, according as the force at the drawbar is a pull or a push, to but one end of the recording cylinder, and all oil which leaks past either piston is carried back to the supply and used again without being allowed to offer any back pressure against the pistons. From this it will be seen that, whether pull or push, the "pull" pen travel is all on one side of the zero or base line. The indication of a pull or push is to be recorded on the diagram just as in the present car, as described in the paper, but by means of a device which depends on the fact that, in changing from a pull to a push or the reverse, the hydraulic check valves in the drawbar cylinder are not reversed until the drawbar piston has been moved to the other side of its central position by 1-16 of an inch; that is to say, all pull records will be taken while the drawbar piston is from 1-16 to 1 3-16 ins. forward of its central position, and likewise all push records when at a like distance to the rear of its central position.

The measurement of the amount of pull or push exerted on the drawbar piston is accomplished by means of helical springs, of known calibration, introduced symmetrically around the outside of the recording cylinder to resist the motion of the piston rod of the same. For the full capacity of 100,000 lbs., since the motion is multiplied 36 times, the total resistance to be offered by the helical springs referred to is one thirty-sixth (1-36) part of 100,000 lbs., or 2,778 lbs. Now, if we suppose that there are six of these helical springs in the nest, all alike spaced 60 deg. apart around the piston rod, each spring would have a load on it of 463 lbs. when there is a load of 100,000 lbs. on the drawbar, and consequently when the springs are compressed the full 10 ins.

If, now, it is desired to make the capacity but 50,000 lbs. for the 10 ins. motion, it can be done by removing every other one of the six, leaving three springs spaced 120 deg. apart. Again, if 33,333 lbs. is the desired total capacity, it can in like manner be had by removing four of the springs, leaving any two diametrically opposite. And, again, by removing any one pair of springs which are diametrically opposite each other, the four springs remaining will have a capacity for the 10 ins. of 66,667 lbs., so that the total capacity of the dynamometer could be made 33,333 lbs., 50,000 lbs., 66,667 lbs., or 100,000 lbs., as desired, or per 1 in. of ordinate one-tenth of these amounts.

From this it will be clear if, instead of making all the six resistance springs alike, they be made in pairs, but each pair of a selected stiffness, it is possible to have, in all, seven different dynamometer capacities from but three pairs of springs. For instance, if one pair is made to give a total capacity of 10,000 lbs., or 1,000 lbs. per inch of ordinate, another pair for 30,000 lbs., or 3,000 lbs. per inch, and the third pair for 60,000 lbs. or 6,000 lbs. per inch, the possible combinations as above explained will give any of the following seven capacities: 10,000, 30,000, 40,000, 60,000, 70,000, 90,000 and 100,000 lbs., or per inch of ordinate one-tenth of these amounts.

By providing an additional pair or so of these resistances, it is possible to conveniently have any capacity or scale that may be desired, depending on the nature of the work to be done. Furthermore, it is not absolutely necessary in all cases to entirely remove the springs in changing from one capacity to another, for any one or more of the resistances may be compressed solid while in position, so as not to be included in the resistance to the motion of the recording piston, when pressure is applied to the recording cylinder from the drawbar piston.

The hydraulic apparatus or dynamometer proper, including the method of applying the resistance springs, just described, is the design of Mr. Albert H. Emery, of Stamford, Conn., who is also the designer and patentee of the weighing mechanism of the present dynamometer car.

The description which has been given in the paper, of the recording mechanism of the present car, will serve to give a general idea of what will be employed in the new one. The motion, however, will be taken from the axle by a screw gear. Since the axle has a motion in all directions relative to the car body, preventing the use of a fixed shaft, two Hooke's (Universal) joints are included in the line of shafting connecting the screw gear and the mechanism to be driven. These joints, as well as the shaft, are made of a new design, with a view to insuring that they will run in perfect balance at high speeds.

In addition to the recording pens mentioned in the paper, there will be one to lay off a mark every 1,000 ft. traveled; by counting the number of spaces thus laid off, the distance between any two points located, or the total distance run, can be promptly determined from the diagram within a small fraction of 1 per cent. Another advantage of this automatic distance spacer is that it provides a means for correction if the paper shrinks or as the wheels on the axle from which the motion is taken wear.

There will also be one spare pen. With the datum pen and pull pen there will be, in all, ten recording pens.

The travel of the paper will be the same as in the present car—52.8 ins. per mile, or 1 in. per 100 ft. The width of the paper diagram has been increased from 14¾ ins. to 18 ins., mainly because of the greater travel of the pull pen, due to the greater capacity of the car. In fact, it is because the 28,000 lbs. capacity of the present car, sufficient 20 years ago, is only 28 per cent. of the capacity thought necessary to provide for to-day that the new car is being built.

Descriptions with drawings which have been published recently by *The Railway Age*, *Railroad Gazette* and American Engineer and Railroad Journal, of the locomotive testing plant exhibited by the Pennsylvania Railroad at the St. Louis Exposition, will be found valuable in this connection to those interested, as the recording mechanisms in the two cases are very similar.

The car will be lighted by electricity by means of a 5 by 6-in. De la Vergne Machine Company vertical oil engine, with direct connected dynamos, in connection with a storage battery, which will also be the means of operating the leakage pump and the eight electric circuits to the dynamometer pens. There will also be sleeping accommodations for eight men, with some other conveniences, including room for a kitchen.

This description was given by Mr. Dunbar in a discussion before the Engineers' Club of Philadelphia.

Definition of "Engineer."—In the charter of the Institution of Civil Engineers the engineer is defined as "Directing the great sources of power in Nature for the use and convenience of man." With all respect to this august body, and their often quoted definition, I would humbly suggest that it is bad. It is really the definition of a scientific man. It is incomplete as applied to an engineer, because it does not take into account the sordid element of price. An American definition is much better: "An engineer is a man who can do for one dollar what any fool can do for two." This is not poetical, and is useless for oratorical purposes; but it is right. It is no use being able to design most complicated alternating current machinery, or being able to explain it with the help of a wilderness of clock faces and several issues of the technical journals, unless the machine, when made, is cheaper than its rivals. Every design, every engineering manufacture, and every piece of engineering is only a question of price. It is unpleasant, perhaps, but it is a hard fact, and we have got to face it.—*J. Swinburne.*

The Value of Difficulties.—Though you may not like it, a hard struggle is very good for a young man who has anything in him. It gets him into the way of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from the mere force of habit. Nearly all great men rise from almost nothing, with infinite trouble in their youth.—*J. Swinburne.*

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A machine tool representative going the rounds of his customers called on a shop superintendent. Answering a question as to what degree of satisfaction a certain new machine was giving, the superintendent said: "That machine is disappointing. It is out of service more than any other in the shop and it is continually breaking down. The men do not like it. I wish you would take it back."

Having permission, the machine tool representative sent a man to ascertain the facts. Being diplomatic and himself an expert workman, the man immediately saw what was wrong. The foreman sent around stock for an ordinary day's run. The man turned up 45 pins, using up the stock, and asked for more. When the piece work inspector looked up the time, it was found that the job had been done in one-quarter of the basis piecework time. Instead of putting the machine back into the hands of the builders, more of them were ordered. This machine narrowly escaped sacrifice because of its excellence and yet the shop superintendent was perfectly sincere. This illustrates the great importance of absolutely reliable information concerning the capabilities of machine tools. It costs money to know what tools will do, but if, by knowing, you may double or quadruple your output, will it pay?

The writer has discovered the difficulty with compounds, and it is too good to keep. It was revealed on a road where compounds are in disfavor and are being changed over into "simples." A traveling engineer (who understood his business) was hired from another road and the very first engine he rode on was a compound. He asked the engineer how the engine worked. The engineer replied, "First rate." The traveling engineer noticed that the starting valve was open and waited for the engineer to close it, as the engine was up to speed, but the valve was not touched. This led to the question, "Are you working as a simple or a compound?" The answer was, "I don't know." "How long have you been running these compounds?" "Eight years." "Do you not use that valve?" "No, I always leave it as it is now." "Even when running fast as you are now?" "Yes." This man had run a compound locomotive in freight service for eight years and did not know the object of the starting valve. He had always kept it "open."

It is not wonderful that compounds are in disfavor on that road. This traveling engineer is supposed to be an honorable man and truthful. Is it possible that other roads are intrusting good compounds to men like this engineer? If so, no one need wonder that they are changed to simples.

EFFICIENCY OF HIGH SPEED PLANER TOOLS.

High-speed tools are much less efficient on planers and shapers than on lathes, drilling machines and boring mills. Some maintain that this is due to the repeated shock to the tool as it enters the work, while others believe that the repeated heating and cooling of the tool has a tendency to anneal it and destroy its temper. A planer manufacturer, who has devoted considerable time in experimental work and study of this question, has come to the conclusion that, while the repeated heating and cooling may be a factor affecting the efficiency of the tool, that the vibration which takes place when the tool is taking a heavy cut is also a very important factor in reducing its cutting efficiency. With the tool taking a heavy cut any considerable vibration of the planer will result in a violent and repeated straining and bending of the point of the tool. The construction of the planer is such that there is an opportunity for much greater vibration than on a lathe. By designing a planer with the object of reducing vibration to a minimum this manufacturer found that he could not only take heavier cuts on a certain class of work, but could increase the cutting speed almost 60 per cent. over what could be used on the standard machines, and the only apparent difference in the machine which would appear to warrant any increase in the efficiency of the tool steel was its greater strength and stiffness, which reduced the vibration to a minimum.

PROPORTIONS OF LOCOMOTIVE SHOPS.

Those who have studied locomotive shop plants with a view of establishing, from best practice, the proper proportions between the various departments will find it necessary to closely watch present developments in order to keep a proper balance between the various factors involved. A large shop plant, built about three years ago, which had at that time an apparently correct balance between the size of the locomotive shop, the boiler shop and the blacksmith shop, has been rather rudely upset by two simple conditions, which have changed with subsequent progress. When the shops were built the road used very little cast steel, forgings being employed exclusively in the small locomotive parts. By the substitution of steel castings for forgings the blacksmith shop is now twice too large.

The boiler shop, however, is not half large enough, and is to be extended at a great expense while the shop plant is yet almost new. The road has purchased much larger locomotives than ever before, and as these are worked to the limit of their capacity, the boiler work has become exceedingly heavy, and as every new boiler is working under a higher pressure than formerly, each boiler requires more work than that which would result from merely increase in the size. Furthermore, with the high pressures it is impossible to repair fireboxes by patching, and nowadays a whole new sheet is required, whereas a patch would have sufficed in the days of 150 lbs. pressure.

A little reflection on the effect of progress, as shown in this particular case, illustrates the necessity for the most careful planning of a railroad shop, for it is not good business policy to spend perhaps a million dollars in a shop plant and after two or three years find it necessary to double the capacity of some of the departments. While the developments of the future cannot always be foreseen, they may usually be fairly

well provided for. This experience points to the absolute necessity in designing railroad shops of placing the responsibility upon those who are in position to know the tendencies, and of giving these officials the authority to provide adequately for the changes which are sure to come. Not until the railroads are prepared to recognize motive power problems and place them in the hands of officials ranking with the vice-presidents of the roads, centralizing the authority very near the president, can these problems be properly, that is to say, economically administered.

MEETINGS AND TEAM WORK.

Meetings of responsible heads of departments at regular intervals present possibilities which cannot be appreciated by those who have not had experience with them. The formal kind of meeting, with stenographic reports, is not what is meant, and the slightest tendency toward speechmaking spoils the ideal. The mere gathering together of men associated in the same general pursuit for a comparison of notes is the desirable thing.

For several years the mechanical department officials of one of the Western roads, including general foremen, master mechanics, superintendents of the car and locomotive departments and the mechanical engineer have met with the chemist, storekeeper and others at noon in a well-equipped lunch room in one of the shop buildings. At that table a pleasant gathering of friends assembles daily, and in an agreeable after-dinner half hour of shop talk many important matters are discussed. The writer has been impressed with the importance of this influence, because the men around that table have often started movements of great value to the road. These men work in close accord. They have an unusual opportunity to learn what their colleagues are "up against," and they discuss their work and their troubles very much as it was done in the old-fashioned family. Conversations at that table have resulted in improvements which have been widely adopted all over the country. On the same road the department foremen meet at a stated time every Monday morning, for a brief session, to consider the plan for the week's work in the shops. The department heads fully understand each others' difficulties, and a helpful spirit exists all around. If a delay is likely to occur in any department its effect is discounted in advance. The boiler shop may have a spare space for a few days for an extra engine. This or that work may be hurried a little in order to preserve the general shop schedule. This practice "takes up" a great deal of lost motion, and is to be most highly commended.

Commercial concerns have used this method with telling effect, and those of the highest standing have for years made a practice of team work of this kind. The plan possesses even greater possibilities on railroads, where daily work presents an almost continuous emergency.

This sort of comparison of notes should be practised also between departments. Much is heard of the shifting of responsibility from one department to another, as if the road were composed of warring factions, each endeavoring to put the other in a bad light to save itself. This sort of thing prevents businesslike management. A monthly meeting to study the performance sheets would be a powerful influence in extending the team work and breaking down the department defenses, which have been a great and entirely unnecessary expense. There is no official who can help a division superintendent more than can the master mechanic and vice versa, if these men understand each others' problems. Time required to obtain such understanding is well spent. For example, the superintendent could help the master mechanic wonderfully if he understood the roundhouse difficulties, and the master mechanic could help the superintendent if he knew more about the trains and traffic. It seems almost absurd to suggest that the efficiency of a railroad organization would be greatly increased if the departments forgot themselves and thought only of the general result. But such a suggestion is urgently needed.

MOTOR CARS FOR STEAM RAILROADS.

In a report recently made to the superintendent of motive power of the Northern Pacific Railway by Mr. W. J. Bohan, the following discussion of motor cars vs. steam locomotives is included:

Three power schemes for driving motor cars have been developed, steam, gasoline or oil engines with mechanical drive, and gasoline or oil engines coupled to electric generators supplying current to motors on the car axles. On the steam driven cars the vertical type of boiler provided with horizontal cylinder is employed (See AMERICAN ENGINEER, November, 1897, page 367, and April, 1898, page 135), coal, coke or oil being used for fuel. Owing to the limited space available for the boiler it has been difficult to obtain sufficient steam capacity and their operation has been more or less unsuccessful on account of boilers not being able to meet demands when maximum power is required. Some foreign roads are operating this class of equipment, but their economy has not as yet been proven.

The gasoline equipments, a number of which are now being tried, have some advantages, chief of which is the fact that they are self-contained and outside of oiling require little attention. They also have a number of disadvantages, among them, the necessity of using compressed air or other means for starting the engines, and their requiring complicated controlling mechanisms and clutches to connect the engines to axles so as to provide for ample power and smooth starting of car. The question of economical operation of gasoline equipment is also doubtful unless gasoline can be purchased at a low price or coal becomes very high, either of which conditions is not in evidence on this line at the present.

The Rock Island Power Committee, reviewing the subject (AMERICAN ENGINEER, April, 1905, page 121), recommends a steam driven car with a large, properly constructed horizontal boiler, using oil for fuel. Oil is recommended as a fuel on account of its being plentiful and cheap along this particular line. What saving can be effected with such a car over a steam locomotive equipped for oil burning is not given.

The Chicago, Burlington & Quincy Railway has recently built a 225-h.p. gasoline electric motor car designed to haul a trailer for carrying passengers, the motor car itself being used for the power equipment, mail and baggage. A test of this car was made recently, but as yet we have no figures on the actual cost of operation.

Equal capacity considered, the apparent saving in fuel to be effected on any of the motor cars is slight, the main saving being clearly one of labor which may be accomplished by doing away with one or more of the train crew. The following are two tables taken from the report of the Rock Island Power Committee showing comparative cost of motor cars and locomotive with train.

Table 1.—Showing saving in operation of a steam driven motor car with a seating capacity of 52 (as used by the Taff Vale Railway Company) over locomotive and four carriages:

	Motor coach cost per train mile. d.	Engine and four carriages cost per train mile. d.
Running.		
Engine coal	1.36	3.03
Water	.12	.36
Oil and other stores	.19	.46
Cleaning	.07	.33
Steam raising, etc.	.09	.10
Washing out	.08	.08
Carriage cleaning	.10	.85
Carriage lighting	.12	[illegible]
Oil	.01	.05
Repairs, Renewals.		
Engines	.95	3.48
Carriages	.51	2.75
Wages.		
Enginemen	1.37	1.[illegible]
Trafficmen	.56	1.45
	5.48 (10.96c.)	14.92 (29.84c.)

Table 2.—Saving in operation of motor car over two-car train with locomotive:

Approximate cost—		
Passenger cars		$5,000
Baggage, mail and express cars		5,000
Engine and tender		7,000
		$17,000
Motor car		12,000
Difference		6,000
Weight of train—		
Passenger car		35 tons.
Baggage car		30 tons.
Engine and tender		65 tons.
		130 tons.
Weight of motor car		65 tons.
Difference		65 tons.
Cost per day for wages—	Train.	Motor car.
Engineer	$3.50	$3.50
Fireman	2.25	2.25
Conductor	3.50	3.50
Brakeman	2.00	
Baggageman	2.50	$9.25
	$13.75	
Add for R. H. care	3.00	
	$16.75	
Add interest on $5,000 at 6 per cent	1.00	
	$17.75	
Cost of operation of train per day		$17.75
Cost of operation of motor car per day		9.25
		$8.50
Saving in fuel per day		5.00
Total saving per day in operation of motor car		$13.50
Capitalized at 5 per cent	$13.50 × 360 =	$97,200
	0.05	

In both of the above tables the comparison is unfair in that the cost of operating one car is compared with the cost of operating an engine and a two or four-car train having greater weight and carrying capacity. In Table 2 the fixed charge should be reversed. The average motor car costs $12,000. The majority of railroads in this country have numbers of locomotives, such as would be required in this service, which they would be glad to dispose of at $2,500 each. The same is true of this class of cars which can only be used for branch or suburban service and the value of which would not exceed $3,000 each. For a comparison of the cost of operating a locomotive and one combination baggage and coach and a gasoline electric motor car of equal passenger and baggage capacity the following seems to be fairer.

Table 3.—Comparative statement showing cost of operating a locomotive and one combination coach and baggage car and a motor car of equal capacity.

A 15 x 22-in. locomotive complete with coal and water weighs 60 tons. A combination passenger and baggage car of equal freight and passenger capacity to a 65-ft. motor car weighs 22 tons. The total weight of the above, for which a motor car would be substituted is 82 tons, with a horse power of about 500 and a speed limit of 60 m.p.h.

Value of the above locomotive is	$2,500
Value of the above car is	3,000
Total	$5,500
Cost of operation per day will be—	
Crew, 1 Engineer	$4.00
1 Fireman	2.35
1 Conductor	3.50
1 Brakeman	2.25
Assuming a 50-mile run doubled each day of 100 miles per day, the locomotive and one car would make 50 miles per ton of coal based on an average speed of 20 miles an hour. The fuel consumption for the above run would be 3 tons per day at $2 per ton	6.00
(One ton of coal allowed for building fires, keeping up steam when not running, etc.).	
Repairs for the locomotive 100 miles at 2½ cents per mile	2.50
Repairs on car, per 100 miles	.50
Roundhouse expense	1.75
Oil, waste and other supplies	.50
Water	.25
	$23.60
Interest on investment at 5 per cent	.76
Total	$24.36

A 200-h.p. combination gasoline electric motor car, length 65 ft., weight 65 tons, baggage and passenger capacity equivalent to the above combination car would cost $12,000.

Based on 40 watt hours power required per ton mile at an average speed of 20 miles per hour, as determined by recent tests. Gasoline estimated at 13 cents per gal., one gal. producing 6½ h.p.h., the cost of operation per day will be:

Crew—1 Engineer	$4.00
1 Conductor	3.50
1 Brakeman	2.25
Gasoline per day (100 miles), at 7c. per train mile	7.00
Gasoline lost by evaporation, waste, etc., 15 per cent	1.05
Repairs based on 100 miles per day, at 3c. per mile	3.00
Terminal expenses	1.00
Oil, waste and other supplies	.50
	$22.25
Interest on investment at 5 per cent	1.53
Total	$23.78

The above comparison shows a saving of 58 cents per day in favor of the motor car. You will note that in the table showing cost of operating the motor car that the wages of fireman is not included. It is a question, however, whether this man can be dispensed with on account of coming in contact with State laws requiring two men in cab, cases of which have been known. The motor car equipment is handicapped in that its hauling capacity and range of speed is limited. The locomotive on the other hand has wider range of speed and in cases of necessity, such as excursions, etc., which are always forthcoming on branch lines, will haul several cars handily. The locomotive can also be used for switching at terminals, which is often desirable.

Summing up the whole situation there seems to be very little in the motor car proposition at present or until their success has been better demonstrated. In case a motor service is desirable on some branch line, why not make the jump from steam to electricity at once and install wiring on branches where current can be bought for around 1 cent per k.w.h. and operate a few street cars, the cost and success of operating which is a certainty.

The Question of Cost.—The *dollar* is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design but also so to design as to insure the best economical result. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies.—*Henry R. Towne, before Purdue students.*

GETTING THE MOST OUT OF A LATHE.

With a belt-driven lathe having a four or five-step cone pulley and back gears, the speed steps are so large that the ordinary operator, if he understands his work, can usually determine which speed is most suitable for the work he has in hand. With a variable speed motor driven lathe a greater number of speeds are furnished, and where these speeds increase by from 10 or 15 to 20 per cent. increments the problem of selecting the most suitable speed for a particular piece of work is more complicated. In some of the very large manufacturing establishments it has been found advisable to have a "speed foreman," whose duty it is to advise the machine hands as to the speed to be used on different classes of work, and in addition he is expected to improve the machine tools and the methods of handling the work, with a view to increasing the output. Such a man must, of course, be thoroughly familiar with the practical part of the work and ordinarily uses one of the special slide rules to assist him in determining the cutting speeds which it is advisable to use on different classes and sizes of work. A man of this kind would undoubtedly be a paying proposition in a very large shop, but would probably be out of the question for the smaller shops.

The problem then is to provide some simple means to enable the ordinary machine hand to easily select the best speed, within reasonable limits, for a given piece of work. It is first necessary to decide on the kind of tool steel which will be used, and then by means of a careful set of experiments and by practical observation to determine the best rates of cutting speed with various materials and under different conditions. As the rate of cutting speed depends on the kind of tool steel, the material to be cut, the nature of the work and the finish required, it is, of course, necessary for each shop to determine for itself the most suitable rates of cutting speed for its conditions. The machine tool operator should then be furnished with data as to the cutting speed in feet per minute to be used with various materials.

It is then necessary to furnish him with some simple (to be effective it must be quite simple) means of determining the proper position of the belt and arrangement of back gears on a belt-driven lathe, or of the controller handle and gearing on a motor-driven lathe to obtain the desired rate of cutting speed on the diameter of work he is to turn.

furnished by the controller there are four runs of gearing, so that a very large number of speeds are available. The letters with each controller point number designate the run of gearing which is to be used; F, means the fastest run; M.F., medium fast; M.S., medium slow and S. slow. This same scheme can easily be adapted for use with boring mills and drilling machines.

This table was made up by the machine shop foreman from

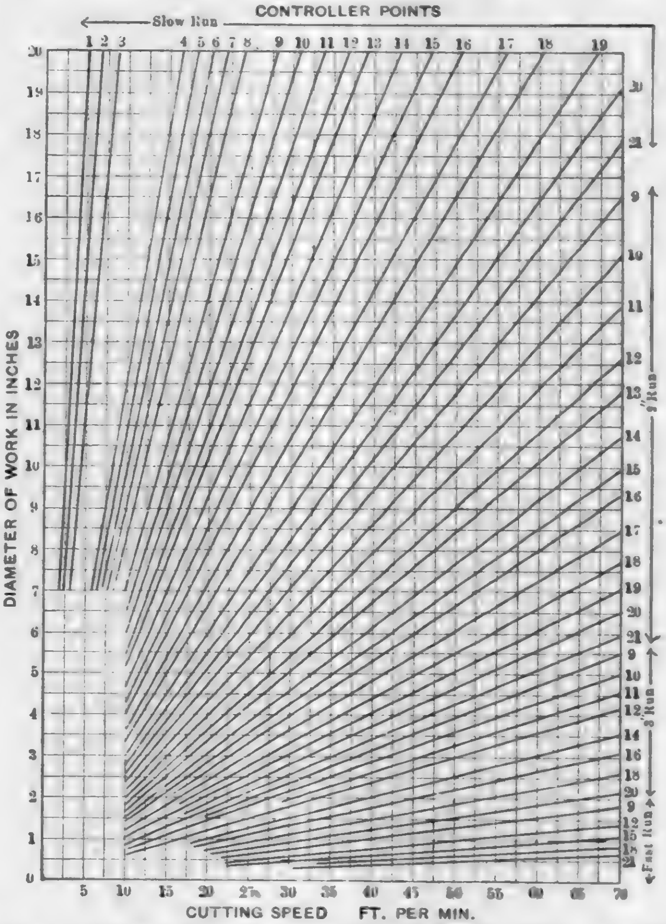


FIG. 2—DIAGRAM SHOWING MOTOR CONTROLLER POINT FOR ANY CUTTING SPEED ON VARIOUS DIAMETERS OF WORK.

CONTROLLER POINTS AND RUN OF GEARING TO BE USED TO OBTAIN VARIOUS RATES OF CUTTING SPEED ON DIFFERENT DIAMETERS OF WORK.

Diameter of Work.	CUTTING SPEED—FEET PER MINUTE.								
	30	35	40	45	50	55	60	65	70
1 in.	M.F.—18	M.F —20	F.— 9	F —10	F.—12	F.—13	F.—14	F.—15	F.—16
2 ins.	M.F.—11	M.F.—13	M.F.—14	M.F.—16	M.F.—17	M.F.—18	M.F.—19	M F.—20	M.F.—21
3 ins.	M.S.—19	M.S.—21	M.F.— 9	M.F.—11	M.F.—12	M.F.—13	M.F.—14	M.F.—15	M.F.—16
4 ins.	M.S.—16	M.S.—18	M.S.—19	M.S.—20	M.F.— 8	M.F.—10	M.F.—11	M.F.—12	M.F.—13
5 ins.	M.S.—13	M S.—15	M.S.—16	M.S.—18	M S.—19	M.S.—20	M.F.— 8	M.F.— 9	M.F.—10
6 ins.	M.S.—10	M.S.—12	M.S.—14	M.S.—16	M.S.—17	M.S.—18	M.S.—19	M S.—20	M.S.—21
7 ins.	M.S.— 9	M.S.—11	M.S.—12	M.S.—14	M.S.—15	M.S.—16	M.S.—17	M.S.—18	M.S.—19
8 ins.	S.—40	M.S.— 9	M.S.—11	M.S.—12	M.S.—14	M.S.—15	M.S.—16	M.S.—17	M.S.—18
9 ins.	S.—19	S.—21	M.S.— 9	M S.—11	M.S.—12	M.S.—13	M.S.—14	M.S.—15	M.S.—16
10 ins.	S.—18	S.—19	S.—21	M.S.— 9	M.S.—11	M.S.—12	M.S.—13	M.S —14	M.S.—15
11 ins.	S.—17	S.—18	S.—20	M S.— 8	M.S.— 9	M.S.—11	M.S.—12	M.S.—13	M.S.—14
12 ins.	S.—16	S.—17	S.—19	S.—20	M.S.— 8	M.S.—10	M.S.—11	M.S.—12	M.S.—13
13 ins.	S.—14	S.—16	S.—18	S.—19	S —21	M.S.— 9	M S.—10	M.S.—11	M.S.—12
14 ins.	S.—14	S.—16	S.—17	S.—18	S.—20	S.—21	M.S.— 9	M S.—10	M.S.—11
15 ins.	S.—13	S.—15	S.—16	S.—18	S.—19	S.—20	M.S.— 8	M.S.— 9	M.S.—10
16 ins.	S.—12	S.—14	S.—16	S.—17	S.—18	S.—19	S.—20	S.—21	M.S.— 9

NOTE.—The motor has a 21 point controller, and drives the lathe through four different runs of gearing. F. indicates that the fast run of gearing is to be used; M.F., medium fast; M.S., medium slow, and S., slow.

FIG. 1.

The best method of doing this which has come to our notice is one used at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad. On the headstock of each lathe is fastened a brass plate with a table on it somewhat similiar to that shown in Fig. 1. The table shown is copied from one on a Putnam 20-in. lathe, and the operator can easily tell at a glance the controller position and run of gearing to use for any rate of cutting speed from 30 to 70 ft. per minute on diameters from 1 to 16 ins. This lathe is driven by a Crocker-Wheeler 7½ h.-p. motor with a 21-point controller operating on the multiple voltage system. In addition to the speeds

the chart shown in Fig. 2, which was furnished to him from the mechanical engineer's office. This chart shows what position of controller and run of gearing to use to obtain any cutting speed from 10 to 70 ft. per minute on any diameter up to 20 ins., but the machine operator would probably experience trouble in reading it, and the table which is much simpler and is sufficient for all practical purposes was made from it. The chart was very easily plotted with the aid of the diagram on Fig. 1, page 165, of our May, 1903, issue, which shows the relation between the speed and power of a Crocker-Wheeler motor using the 21 point field weakening controller.

SUPERHEATERS IN LOCOMOTIVES.

BELGIAN STATE RAILWAYS.*

The Belgian State Railway has recently put in service a series of simple expansion locomotives, the boilers of which carry a pressure of 14 atm. (205.8 lbs. per sq. in.), with an inside diameter of 1.600 m. (5 ft. 3 ins.) while that of the cylinders is 520 mm. (20½ ins.). This class of engine gives the maximum power obtainable by the simple expansion of steam. In fact every new enlargement of the cylinders would demand larger dimensions for the crank-axle and moving parts; on the other hand, the necessity for clearing the loading-gauge limits the diameter of the boiler; in short, with simple expansion it would be difficult to utilize steam with a pressure exceeding 14 atm.

Under these conditions and in view of further increasing the power of the engines, it becomes necessary to resort to some other system for increasing the useful work of the steam without enlarging the existing boilers. The two solutions under consideration are compound working and superheating of the steam. The first of these does not strictly come within the limits of this paper. Arrangements for producing superheated steam and the results obtained with a system that has been in service for more than a year will now be considered.

SCHMIDT SUPERHEATER FOR SIMPLE EXPANSION LOCOMOTIVES.

For some time the locomotive department had their attention drawn to the favorable results obtained by using superheated steam in industrial stationary engines. By superheating the theoretical cycle is improved, and the pressure is maintained. The volume of steam is augmented proportionately to the rise of temperature, diminishing, however, its density. In other words, when the degree of superheat is sufficient to prevent the loss due to condensation in the cylinders, then the surplus heat contained in superheated steam is sufficient to reheat the walls of the cylinders, maintaining the temperature necessary to get rid of the condensation and the loss of work during expansion. These trials have brought to light a valuable property of superheated steam. It was recognized as a bad conductor of heat, contrary to that which obtains when steam is in the saturated state.

These numerous advantages, tested by many trials undertaken by most competent engineers, are specially valuable to the locomotive engine. The employment of a practical superheater augments the power of the boiler, and the utilization of superheated steam is most economical. This is well observed in hauling heavy goods trains on sections of the line having heavy gradients. For it is then indispensable to reduce to the minimum the consumption of water and steam. For the suburban trains having frequent stoppages superheat is again highly recommended, because it reduces the condensation necessitated by the frequent stops. High speed is also favorable to the employment of higher superheated steam, the great fluidity of which, as well as its dryness, permit running with early cut-offs, which helps the boiler just at the time when it is most hard pressed.

On the other hand, the passage of saturated steam through the pipes (and steam ports) is more difficult, and entails inevitably an increase of condensation. Having in mind these various theoretical and practical considerations the administration of the Belgian State recognized the great utility of pushing on their investigations in this direction.

It was in 1900 that the administration of the State Railways opened negotiations with M. Schmidt, the German expert, who at that period had already introduced some locomotives with steam superheaters formed principally of a series of rings placed in the smoke-box.

This last plan, described in most of the technical newspapers, and applied to a Prussian State locomotive shown in Paris in 1900, adapted itself without difficulties to outside cylinder engines.

*A paper by J. B. Flamme, general inspector Belgian State Railways, read before the Institution of Mechanical Engineers.

It is not quite the same for inside cylinder engines which, as in England, are generally used in Belgium. In this case it becomes impossible to clear from the bottom of the smoke-box the cinders brought by the large flame-tube placed at the base of the barrel.

On the other hand, a superheater, established in the barrel of the boiler and described later (Fig. 4), offers some real advantages. It is lighter, less cumbersome, easy to clean and maintain, and its introduction does not necessitate any important modifications in the smoke-box. Consequently it was this kind of apparatus that the Locomotive Department adopted in a new type of powerful locomotive then being built in the Cockerill Works at Seraing.

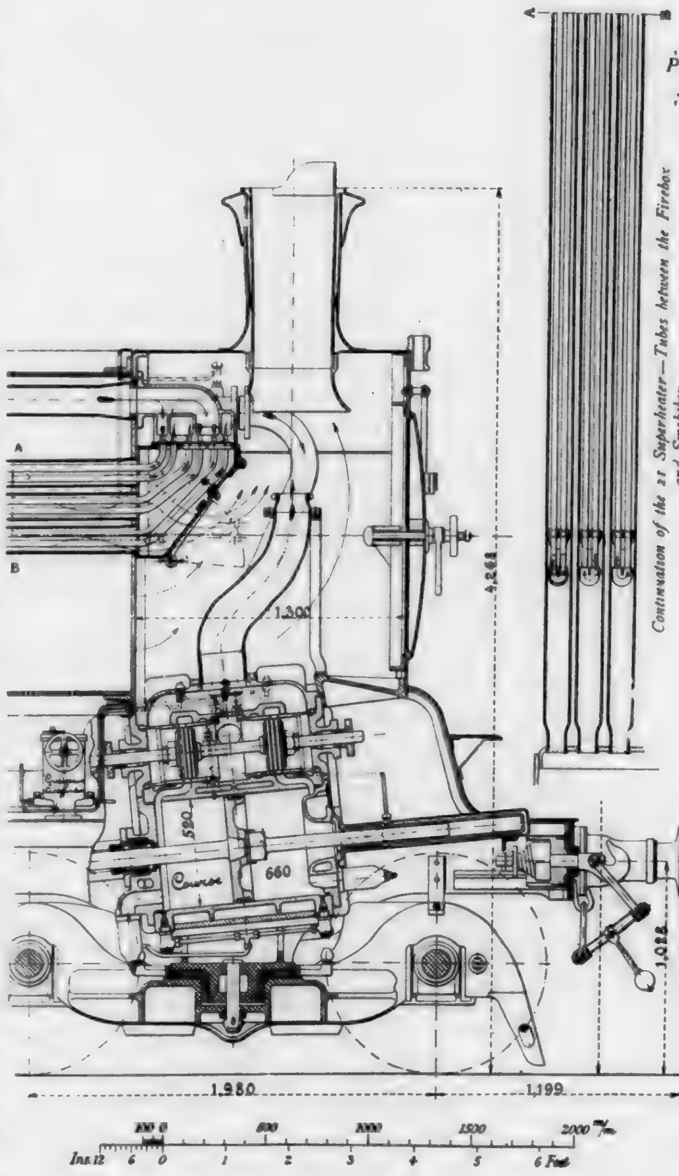


FIG. 1.

At the same time another important question presented itself. Was it absolutely necessary to superheat the steam to a temperature reaching 300 deg. to 350 deg. C. (572 deg. to 662 deg. F.)? It is evident that the more the steam is superheated the more necessary it becomes to give attention to the oiling of the piston-valves and cylinders and to the construction of the stuffing-box. With a view to getting a clear idea of the actual amount of superheat some trials were made with a superheater of small surface installed in the barrel of one of the locomotives, type 35, which will be described later. After several months of experiments it has been recognized that the utilization of steam slightly superheated does not offer any appreciable economy of fuel or increase of power.

On the other hand, with the Schmidt apparatus placed on a

locomotive, type 35, and provided with steam with a temperature varying between 300 deg. and 350 deg. C. (572 deg. to 662 deg. F.), some favorable results have been obtained.

The locomotives compared, one using saturated steam and the other superheated steam, are both of type 35, with six coupled wheels of 1.600 m. (5 ft. 3 in.) with bogie in front. The boiler has a round-topped fire-box, the roof of the furnace being connected to the arch by vertical stays. The fire-box, of a medium depth, burns coal with briquettes varying in quantity with the weight of the trains. The inside cylinders are made with piston slide-valves placed above, steam being admitted in the middle of the valve. This arrangement, with the Stephenson valve-gear, involves the employment of a rocking-shaft, which reverses the position of the valves compared with those having the exhaust port in the middle of the piston-valves.

The six coupled wheels and the bogie are fitted with compressed-air brakes. The engine is illustrated in Figs. 1 to 3. The principal dimensions are given in the following Table:

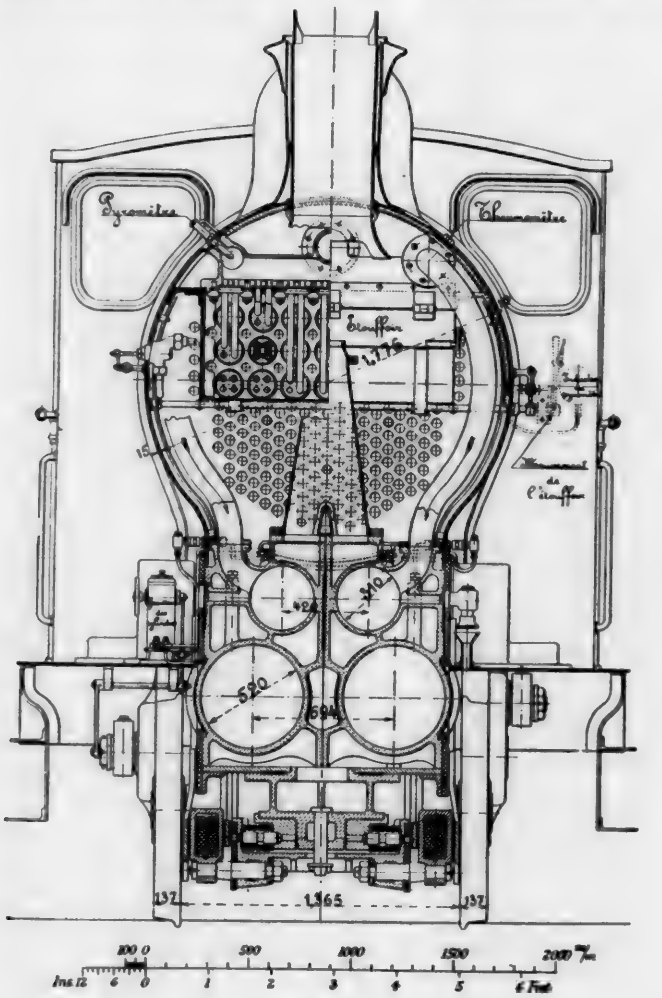


FIG. 2.

Cylinders:—	
Diameter	520 mm. (20½ ins.)
Stroke	660 mm. (26 ins.)
Working pressure	14 atm. (205.8 lbs. per sq. in.)
Diameter of driving wheels	1.600 m. (5 ft. 3 ins.)
Height of center of boiler above rail	2.650 m. (8 ft. 8 5-16 ins.)
Tubes:—	
Length	4.130 m. (13 ft. 6½ ins.)
Exterior diameter	50 mm. (1 15-16 ins.)
Number	271
Heating surface:—	
Tubes, internal	158.25 m². (1,703 sq. ft.)
Firebox	14.90 m². (160 sq. ft.)
Total	173.15 m². (1,863 sq. ft.)
Grate surface	2.84 m². (30½ sq. ft.)
Weight in running order:—	
First axle	9740 K. (9.5 tons.)
Second axle	9740 K. (9.5 tons.)
Third axle	18215 K. (17.9 tons.)
Fourth axle	17850 K. (17.5 tons.)
Fifth axle	17500 K. (17.5 tons.)
Total weight	72965 K. (71.8 tons.)
Adhesion weight	53565 K. (52.7 tons.)
Tractive effort $\frac{p\ d^2\ l}{D}$ =	16128 K. (15.8 tons.)

The engine provided with the Schmidt superheater has less heating surface than the above, owing to the substitution of 21 tubes of 118 mm. (4⅝ ins.) diameter for 103 tubes of 50 mm. (1 15-16 ins.). For this locomotive the internal heating surface in the tubes is 98.10 m.² (1,056 sq. ft.) and the total heating surface is 130.056 m.² (1,400 sq. ft.).

The exterior superheating surface is equal to 27.15.

The superheater proper is illustrated in Plates 1 to 3, and consists essentially of two parts.

(1) A series of iron tubes of 118 mm. (4⅝ ins.) external diameter, occupying the upper part of the nest of tubes and offering like them a passage for flame and hot gases.

(2) Some U shaped tubes grouped in pairs among the flame tubes and used for the circulation of the superheated steam.

A steam collector in several divisions is placed on the top of the smokebox. Some supplementary parts complete the system.

There must also be a diaphragm to close the flame tubes

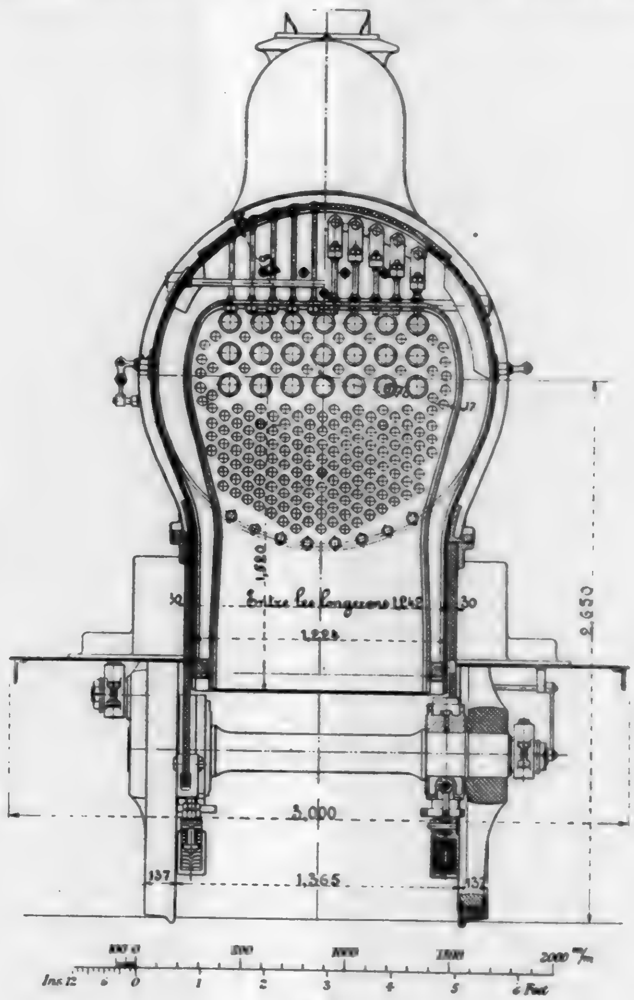


FIG. 3.

when steam does not circulate in the superheating tubes. This diaphragm is handled by the aid of a lever near the engine driver.

A mercury thermometer shows the temperature of the superheated steam at the entrance of the steam-pipe. The degree of superheat is read on a graduated quadrant placed in the cab.

The large flame tubes, which are of solid drawn iron, are screwed into the firebox tube plate and expanded in the smokebox tube plate.

The superheating tubes, also of solid drawn iron, are protected against the action of the flame at the fire end by cast steel caps.

In the smokebox these tubes are expanded into flanged bushes fixed by bolts. The tightness is assured by means of asbestos joints.

Copper, bronze and brass are usually excluded from all parts that come in contact with the superheated steam. For this reason the steam pipes are of iron, and the joints between these pipes and the cylinders are formed with cast iron flanges.

The metallic packings of the piston rods and valve spindles are composed of cast rings and white metal, the contact of which on the rod is obtained by a spring permitting small side movements of the rod.

The slide valves are cylindrical with steam admission in the middle of the valve, which reduces the packing to simple bronze rings with lubricating grooves. The slack between each valve and the cylindrical chamber against which it rubs is closed by means of three cast iron rings of suitable section, the steam pressing on the interior of the principal segment. The oiling of the cylinders and valves is done by a lubricator in six sections. The lubricant used is a mineral oil with a high flash point.

The trials of these two locomotives took place with goods trains of accelerated speed and local passenger trains running on the Luxemburg line, the extremely undulating profile of which contains many inclines of 16 per 1,000.

Each locomotive worked twenty-four goods trains weighing 250 tons (246 tons) and twelve passenger trains weighing an average of 150 tons (147.6 tons). The total journey made by each engine amounted to 11,500 kilometers (7,146 miles). The saving of coal per train-kilometer in favor of the superheated steam engine was found to be 13.33 per cent., and the water consumption was reduced 18 per cent.. On the other hand, the expenses of lubricating increased in a fixed proportion.

After four months of trials on the Luxemburg line, more precise experiments were organized with the through passenger trains on the Brussels and Charleroi line, which has a series of inclines of 13 per 1,000. For ten days, during which the climatic conditions remained invariable, these two locomotives hauled alternately the same train of 250 tons (246 tons). The saving in favor of the superheated steam locomotive amounted to 12.5 per cent for fuel and 16.5 per cent. for water. Moreover the speed raised at the top of the incline showed an average increase of 9.5 per cent., all the conditions being exactly the same.

As regards maintenance the superheated steam locomotive type 35, has not required special attention during its 1½ year's service.

These early favorable results have led to the Belgian State Railway venturing on the application of superheat to locomotives, on a larger scale. With this in view twenty-five locomotives, comprising five different types, all provided with the Schmidt superheater described above, are actually in course of construction or are about to be put to work.

Amongst these last are a certain number of locomotives of type 35, which have fully confirmed the favorable results obtained by the first engine of this kind.

Among the number of services actually and successfully run by these engines is to be particularly noted the hauling, from Brussels to frontier, of express trains going to Paris. These trains, whose tare weight of vehicles exceeds 340 tonnes (334⅝ tons), surmount the 17 kilometers (10.56 miles) separating Mons and the frontier in 17 minutes, against a continuous up grade with inclines varying from 1 in 125 to 1 in 55.

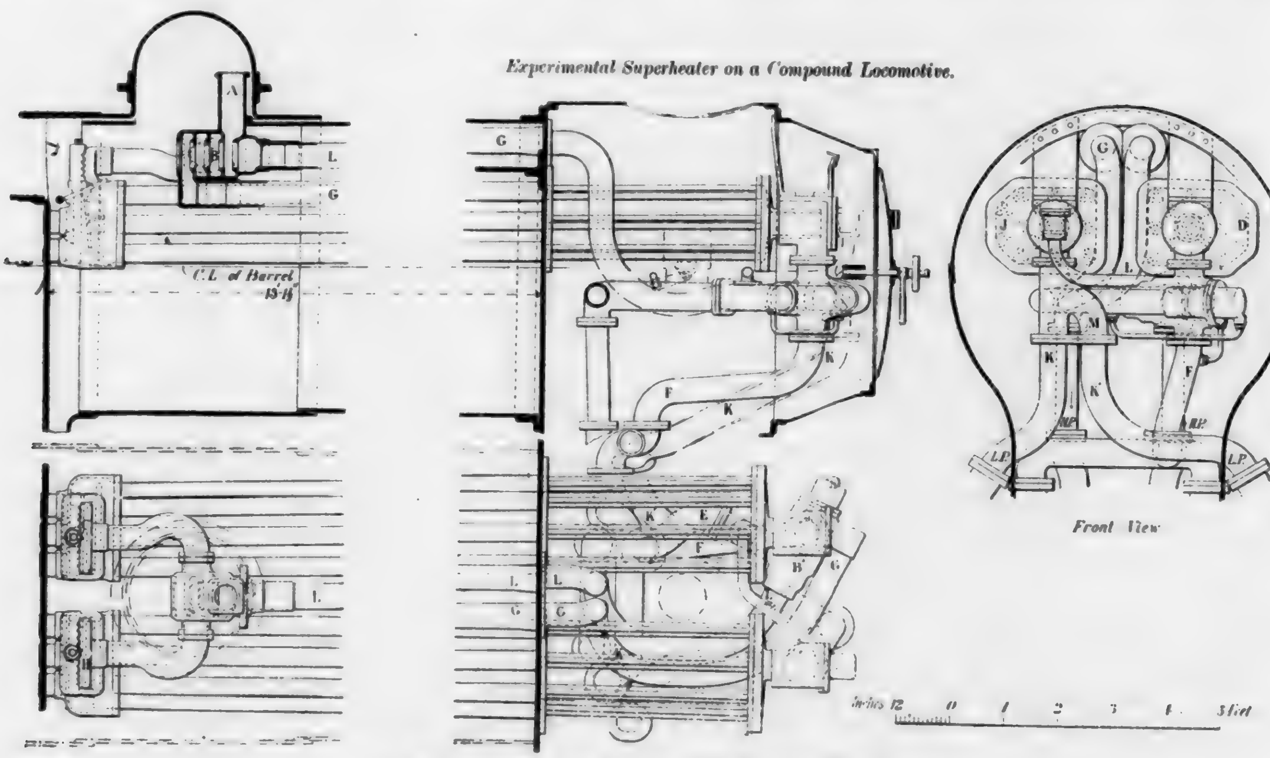


FIG. 4—COCKERILL LOCOMOTIVE SUPERHEATER.

COCKERILL SUPERHEATER FOR COMPOUND LOCOMOTIVES.

It is seen from the preceding that it is now known that superheated steam as applied to locomotives is susceptible of giving remarkable results which come within the domain of practice. The State Railway has decided to persevere with their experiments in combining superheat with compounding, because they perceive that there is a most interesting question to elucidate.

Is it more economical to divide the superheater into two parts in such manner as to raise the temperature at the entrance to both the H.P. and the L.P. cylinders, or, on the other hand, to devote the whole power of the apparatus to superheating the steam before it enters the L.P. cylinders? The Cockerill Company, after numerous investigations, have just completed a superheater that will enable them to settle this question.

This entirely new system is being continually tested on a series of compound engines, with four cylinders, and six-coupled wheels of 1.80 m. diameter (5 ft. 10 ins. diameter) with a bogie. This locomotive, called 19*bis*, possesses a boiler having an interior diameter of 1.65 m. (5 ft. 5 ins.) diameter, and is pressed to 15.5 atm. (227 lbs. per sq. in.).

The H.P. cylinders are inside and connected to the leading coupled axle; the L.P. cylinders are outside and drive the second axle. The four cylinders are placed on the transverse axis of the bogie. The two valve motions of the Walschaert type are outside. They present several peculiarities due to the employment of cylindrical valves, with the steam introduced in the middle. The leading dimensions of the engine, type 19*bis*, are shown in the Table below:

Diameter H.P. cylinders	= 0.36	14 3-16 ins.
Diameter L.P. cylinders	= 0.62	= 24 13-32 ins.
Stroke	= 0 68	= 26 25-32 ins.
Initial pressure	= 15.5 atm.	= 227 lbs. per sq. in.
Diameter of driving wheels	= 1.80 m.	= 5 ft 11 ins.
Height, rail to center of boiler	= 2.80 m.	= 9 ft. 2⅝ ins.
Tubes:—		
Length of	= 4 0 m.	= 13 ft. 1½ in.
Number and outside diameter	= 30 of 107 mm.	= 4 7-32 ins.
	= 219 of 50 mm	= 1 31-32 ins.
Heating surface:—		
Interior of tubes	= 157.62 m².	= 1,696 6 sq. ft.
Of firebox	= 18.35 m².	= 197.5 sq. ft.
	175.97 m².	= 1,894.1 sq. ft.
Area of grate	3.01 m².	= 32 3 sq. ft.

The apparatus for superheating the steam may be used in two ways. One may heat the steam near to the entrance to the H.P. cylinder, and afterwards near to those of the L.P. cylinders, or at the entrance of the L.P. only. The superheater shown in Fig. 4 indicates the general arrangement, comprising two series of large flame tubes containing the circulating pipes intended to superheat the steam.

The role of the compartments C and H, placed inside the barrel, and of the collectors J and D, installed in the smokebox, will be dealt with later on in connection with the explanation of the working of the apparatus.

In B there is a valve with three pistons to divert the steam coming from the regulator towards the compartment C, or into the tube L, according as it is required to operate the superheat to H.P. and L.P. or to L.P. only. The movements of the valve B are automatically repeated, thanks to the presence in the tube L of an identically similar valve located within B¹. The destinations of the different pipes is made clear by following the course of the steam as explained below.

First Case.—Superheat at the entrance of H.P. and L.P. The steam on leaving the regulator A makes its way, after passing B, towards the compartment C; from there it traverses the left set of superheater tubes and enters the collector D, whence it goes to the H.P. cylinders by passing through the valve B¹ and pipes E. The superheated steam, after doing work in the H.P. cylinders, goes out by the exhaust pipe, traverses the valve B¹, after the pipe G, lodged in the interior of the barrel to enable it to enter the compartment H. From there the steam goes into the superheating tubes (the right set), and arrives by the pipe K leading toward the L.P. cylinders.

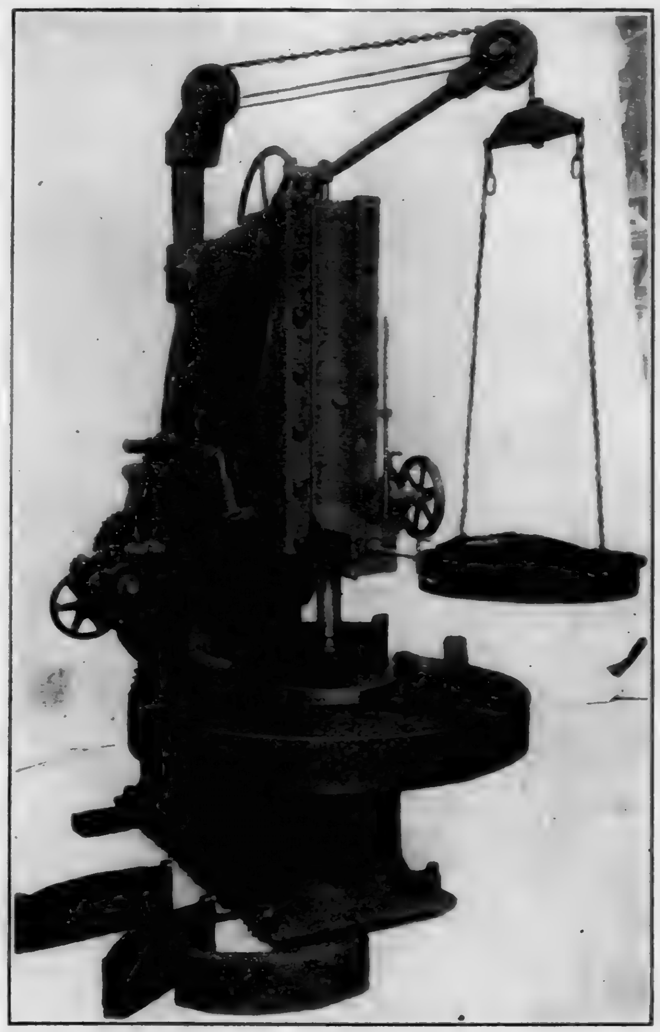
Second Case.—Superheat at the entrance of the L.P. cylinder. The valve B is placed by the driver in a position that diverts the direction of the steam, directly from the regulator into the pipe L; from there it goes to the H.P. cylinders after having passed through the valve B¹ and the delivery pipes E. On leaving the H.P. cylinders the steam traverses the pipes F, the valve B¹, and enters into the collector D. From the front it passes back through the left set of superheater tubes and arrives at the compartment C. From this it passes through the valve B into the compartment H, and traverses through the right group of superheater tubes, whence it goes into the collector J, and from there by the delivery pipes K into the L.P.

A locomotive of type 19*bis*, showing this pattern of superheater, is exhibited in the Liége Exhibition. Trials are going to be continued with a second identically similar engine, to determine which is the more advantageous mode of working to adopt for the new superheater.

It is manifest that if the superheat is required at the entrance of the L.P. cylinders only, it will be possible to dispense with a certain number of parts of the superheater and by that means remedy the obstruction in the smokebox.

CAR WHEEL BORING MACHINE.

The Sellers car wheel boring machine, shown in the accompanying illustration, has several important features which enable it to handle the wheels from the floor to the table, bore and replace them on the floor at a rapid rate with a minimum amount of labor and responsibility on the part of the operator. The universal chuck is so designed that the act of starting the machine causes it to close upon the wheel and hold it securely in place. The stopping of the table automatically opens the chuck jaws and releases the wheel. By the movement of a hand lever the table may be instantly stopped without shock, thus saving the time ordinarily lost



SELLERS' CAR WHEEL BORING MACHINE.

while it is slowing down. The crane mechanism is such that when the wheel is raised to the proper height for swinging it on the table the hoist automatically stops, and when the operator has swung the wheel into position it gently drops into place.

The boring bar is very stiff and has double cutters, having four cutting edges, thus insuring quick and accurate work. The locking device is such that the cutters may be changed without loss of time. A convenient slide rest is provided for facing the hubs. The table is 50 ins. in diameter and the chuck takes 42-in. wheels. The feeds range from .04 to .87 in. This machine is made by William Sellers & Co., Inc., Philadelphia, Pa.

A Hint.—I think if I were an apprentice in a great company's works I should hunt up some place where work had congested, and I would ask for a chance at the job. I would master it in such a way that I would forthwith be intrusted with a continuance of duties that would tax my resources and insure my growth. A mark is put upon such a man.—*F. H. Taylor, before the Electric Club.*

METHOD OF INSTALLING FLEXIBLE STAYBOLTS.

By B. E. D. Stafford.

It is of the most vital importance to the success of the flexible water space stay that good work be always done in the installation of the complete bolt. There is no excuse for leakage when proper attention is given to methods of installation of a flexible stay, and in tapping the taper holes, which are made in the outer sheet to receive the sleeves, such should be carefully inspected and all plugs and sleeves screwed up to a steam tight fit, and all plugs and all caps which make their seat on the end of sleeve should be screwed up tightly, using graphite in the threads, for by the unscrewing of the caps we are allowed to inspect the staybolt proper, when thought advisable.

Fig. 1 is the method of removing the old bolt by using an enlarged twist drill, following the prick punched center of old bolt, drilling through outer sheet and using a reduced diameter of drill through inner sheet, collapsing the end (C), or separating such by a Wagstaff drill, leaving the hole in outer sheet enlarged ready for roughing reamer for the flexible staybolt sleeve.

Fig. 5 is a butt mill, which enlarges the hole in like manner, from tap drill size.

Fig. 2 is a roughing reamer (B), with guide bar (A), to be used in air drill to quickly straighten and size the hole in outer sheet.

Fig. 3 is a finishing reamer, with guide bar, for exactly sizing each hole previous to tapping.

Fig. 4 is a taper tap with guide bar, ¾ in. taper to the foot, 12-V threads, for finish tapping the hole in outer sheet to receive the sleeve. Taper tapping differs from straight tapping. The reamed hole should always be of exact size for the tap to give good full threads. The tap should not be used to enlarge the hole, for this process is both unmechanical and detrimental to the tap. A straight tap of the right diameter used before the taper tap, facilitates the tapping operation and relieves the taper tap from great strain and clogging.

Fig. 6 shows the method of tapping the inner sheet with the regular staybolt tap to aline with the installed sleeve. A cap (B) of the style (D) flexible stays is used as a means for holding the bushing (C), which holds the shank of the tap in line.

The sleeve is screwed into the outer sheet by the stud nut shown in Fig. 8, and as it takes nearly two turns to make a steam tight fit, after the sleeve just fills the tap hole, it is necessary that the tapping operation should be guaged accordingly.

Fig. 7 shows the style (D) both installed ready for riveting over the end (F). B is a cap such as is used for the flexible stay, cut away for the admission of a dolly bar, bucking tool or holder-on. This cap protects the sleeve face where the cap makes a steam tight joint during the riveting operation. The dolly bar or holder-on is made of a piece of axle, 4 or 5 ins. in diameter. C is a tool steel plug inserted therein, hardened and tempered.

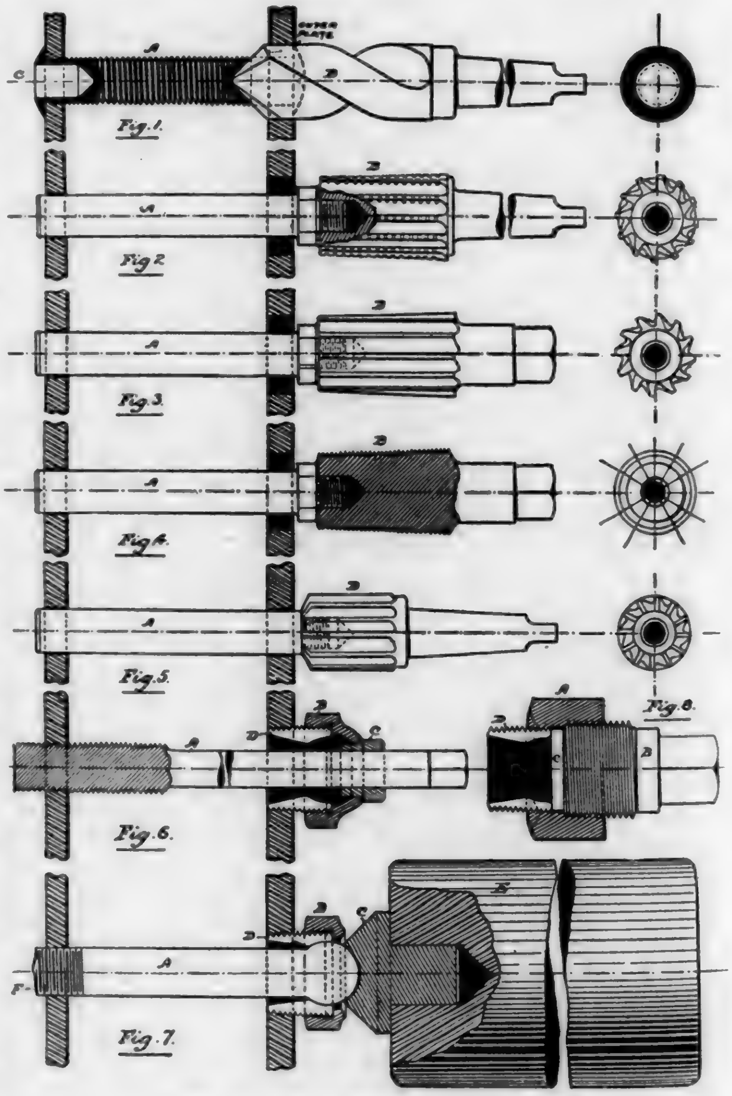
The style of bolt here shown can be put in place with an alligator wrench on the firebox end or by means of a slot in the head. Flexible staybolts should not be installed alternately, which has been done in some cases, for it is but a short time before the rigid water space stay has to be taken out and the flexible stay incorporated to effect a sensible installation. There is no rule to apply regarding the selection of the installation for flexible water space stays other than to cover completely the natural breaking zone of each style firebox.

The cost of flexible stays range from 40 cents to 70 cents apiece, complete, with bolt. The cost of installing the flexible water space stay with proper tool equipment and systematic methods should not exceed 25 cents per bolt, and when installed in large quantities the cost should be as low as 15 cents per bolt.

In comparing the relative cost of maintaining a firebox for four years having rigid staybolts in which the breakage amounted to 40 per cent. with a similar box in which 40 per cent. of the bolts were flexible, the author showed that the outlay for staybolts in the former would be $600 as against $328 for the latter.

The stresses which tend to rupture a staybolt are: That which operates to tear the bolt apart, the tensile stress; that tendency to break it, transversely or crosswise, due to expansion of fire sheet, the transverse stress; and that due to shear which tends to strip the threads from the bolt and hole in the sheet.

The fact that staybolt breakages have in no sense diminished, regardless of the quality of iron used and the many modifications of the forms devised in the rigid stay in the



INSTALLING FLEXIBLE STAYBOLTS.

effort to provide flexibility, notwithstanding that water spaces have been widened, leads us to conclude that the firebox as now constructed is too rigidly stayed to allow of economic and safe working where cost of maintenance of the complete machine is more or less affected in consequence of the expense accruing from the firebox and staybolt charges of repairs incident to the constant disintegration and destruction of material, the result of shock, strain, vibration, corrosion and heat.

The force which works on the fire sheet in its course of expansion, due to high temperatures of furnace heat, throws a stress on the outermost fibres of the rigid staybolt far in excess of the tensile stress, and as it is a reversal or vibratory stress the effect on the structure of the staybolt iron is too severe to warrant safe conclusions as regards maintaining a reasonable factor of safety.

The transverse stress breaks the rigid staybolt, not the tensile stress, and to enable the expansive forces to take their natural course with least resistance the flexible staybolt has been designed as a water space stay, as the most perfect means of affording and maintaining flexibility under all conditions of firebox service, adding to the life of both sheet and staybolt.

These comments and observations were presented in a paper before the Railway Club of Pittsburgh.

LIFTING MAGNETS.

A new application of electricity suitable for railroad shops, and one that promises to very greatly increase the efficiency of the electric crane in handling metallic material, is the lifting magnet, a few applications of which are shown in the accompanying illustration. While at the Wellman-Seaver-Morgan Company works, at Cleveland, the writer had an opportunity of seeing one of these magnets at work in the stock yard of the steel foundry. One of the most interesting operations was that of handling steel borings and turnings. It is practically impossible to shovel these, and it is very slow and laborious to handle them with a fork. With the magnet it was possible to take up about 700 lbs. of this material at one time, and this was hoisted about 15 ft. high, and the crane then carried it to the stock pile, 70 ft. away. Only 55 seconds elapsed from the time the magnet started to pick up the load until it had returned for another one. A short time ago five carloads of pig iron, averaging 30 tons to the car, were lifted out of the car to a height of about 15 ft. and transferred to the stock pile, 75 ft. away, in four hours.

To use the magnet, it is only necessary for the crane man to lower it over the object to be lifted and throw the switch which controls the electric current. Opening the circuit releases the load. No time is lost in adjusting chains, and the magnet never drops its load unless the operator cuts the current off. No ground helper is required except where it is necessary to adjust the load when small pieces, such as billets, are handled. Less room is required than where the ordinary forms of tackle are used, and the available storage room in stock or scrap yards is thereby considerably increased. The magnet is made from such a grade of steel that it drops its load instantly when the circuit of the energizing coil is opened. This coil is heavily insulated and treated by a vacuum impregnating process, which insures it against grounding or short circuiting. It is completely inclosed and protected by the heavy casting, which is ribbed to provide for the rapid radiation of the heat from the coil. The current is led to the coil through a plug connection, and when it is desired to detach the magnet from the crane hook this plug is simply pulled out. The controller switch for operating the magnet is placed in the crane cab.

The amount of current required to operate the magnet, of course, depends upon the amount and kind of material to be handled, but the comparatively small amount which is required under ordinary conditions is surprising. The illustrations show only a few of the many applications of this device. A special form of magnet is made for handling long iron or steel sheets. The magnet illustrated can easily handle six 100-lb. kegs of nails at one time. The writer saw it lift a 11,000-lb. skull cracker, used for breaking up very heavy defective castings. The entire operation was conducted from a safe distance by the crane man. The skull cracker was instantly detached, and the aim was very accurate, as there was no jerk of a latch hook rope tending to destroy it. A number of these magnets, which are made by the Electric Controller & Supply Company, Cleveland, Ohio, are now in successful operation. The device is not experimental, but is the result of years of experience.

HANDLING STEEL TURNINGS AND BORINGS. LIFTING COILS OF WIRE. UNLOADING CAR OF BUTTS OR CROP ENDS.

A FEW EXAMPLES OF WORK DONE WITH THE LIFTING MAGNET.

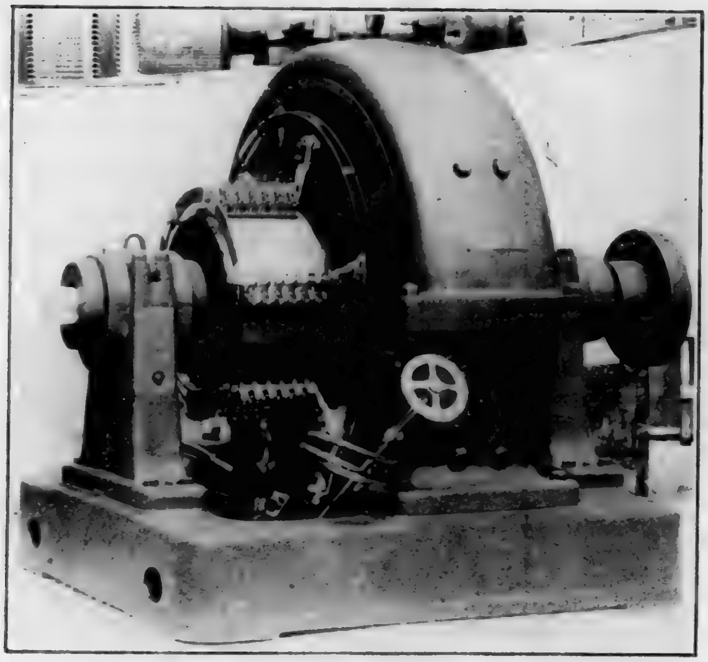
WESTINGHOUSE DIRECT CURRENT GENERATORS.

A new line of Westinghouse direct current self-contained generators, designed for railway, lighting and industrial service at 125, 250 and 550 volts, is shown in the accompanying illustrations. These generators are adapted for belt driving or for direct connection to water wheels, steam engines or other prime movers where frames with bearings are desired. While their general appearance differs from earlier forms, the essential features characteristic of Westinghouse apparatus have been retained, and the changes consist chiefly in the more efficient use of the materials employed in their construction and of mechanical modifications which make possible a more effective adaptation of the generators to modern methods of driving.

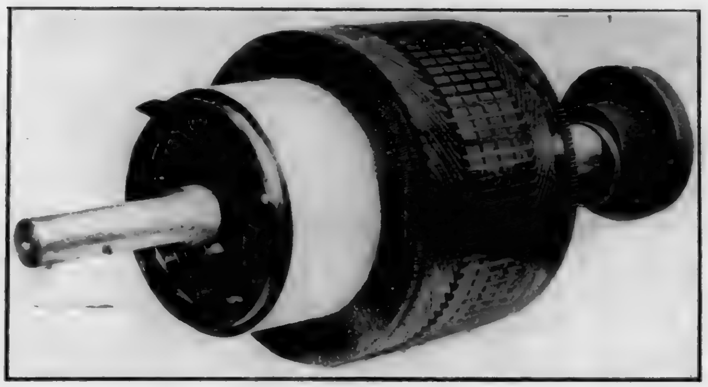
The frame consists of a circular yoke of cast iron divided horizontally into two parts and mounted upon a bed plate of cast iron, to which are bolted the pedestals which carry the armature bearings. Laminated poles with spreading tips are bolted to the frame, and any pole and its coils may be removed without disturbing either the armature or frame. The shunt and series field coils are separately wound and are held in place by the spreading pole tips. Ventilating spaces are provided between the coils and between coils and poles in such a way that thorough ventilation is secured. The coils are taped and impregnated by processes which make them entirely moisture proof. The field windings are regularly proportioned, so as to provide an increase of potential of about 10

per cent. at the terminals from no load to full load, though other compounding may be obtained if desired.

The armature core of the slotted drum type is formed of carefully annealed punchings built up on a cast iron spider, on an extension of which the commutator is mounted. Liberal ventilating ducts make possible a thorough circulation



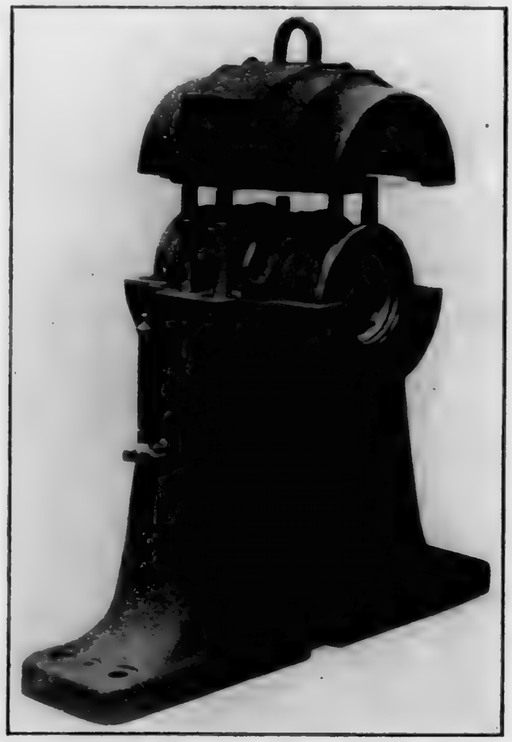
WESTINGHOUSE DIRECT CURRENT GENERATOR.



GENERATOR ARMATURE.

of air while the machine is in operation. Coils formed of copper strap are used, and are held in their slots by fiber wedges. The generous proportions of the commutator insure the best commutation and low temperature under all normal conditions of operation. No part of the rocker ring supporting the brush holder arms projects over the commutator, and the carbon holders and commutator are thus readily accessible at any point. The carbon holders are of the sliding type with shunts, the tension on the brushes being obtained by long, flat, spiral springs which give a uniform pressure over a wide range of movement without change in adjustment. The brushes and moving elements are light, and follow the surface of the commutator without chattering. Separate pedestals bolted to the bed plate support bearings of the Westinghouse self-oiling type, which consist of cast iron shells lined with babbitt metal and lubricated by means of rings which ride upon the shaft and dip into large reservoirs filled with oil. The bearing housings and shells are divided horizontally into two parts to facilitate mounting and removal.

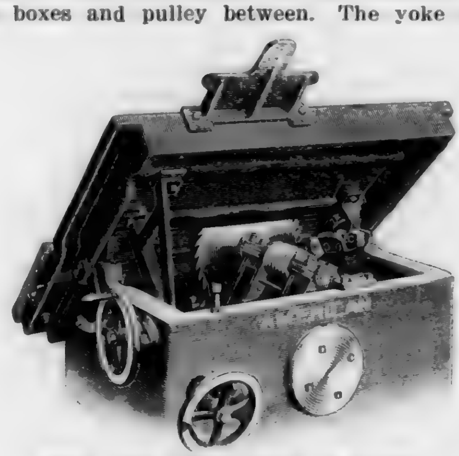
In the larger multipolar machines with parallel wound armatures, sparking at the brushes, wasteful heating in the armature winding and abnormal magnetic strain upon the armature—troubles occasioned by inequality in material or by displacement of the armature from the center of the field—are completely obviated by the following method of balancing the magnetic circuit. A number of points in the armature winding which are normally at equal potential are connected by leads through which balancing currents may pass from one section of the winding to others. These correcting currents are alternating in character, leading in some coils and lagging in others, and consequently magnetize or demagnetize the field poles in such a way as to produce the necessary magnetic balance.



PILLOW BLOCK, WITH CAP RAISED, SHOWING BEARINGS.

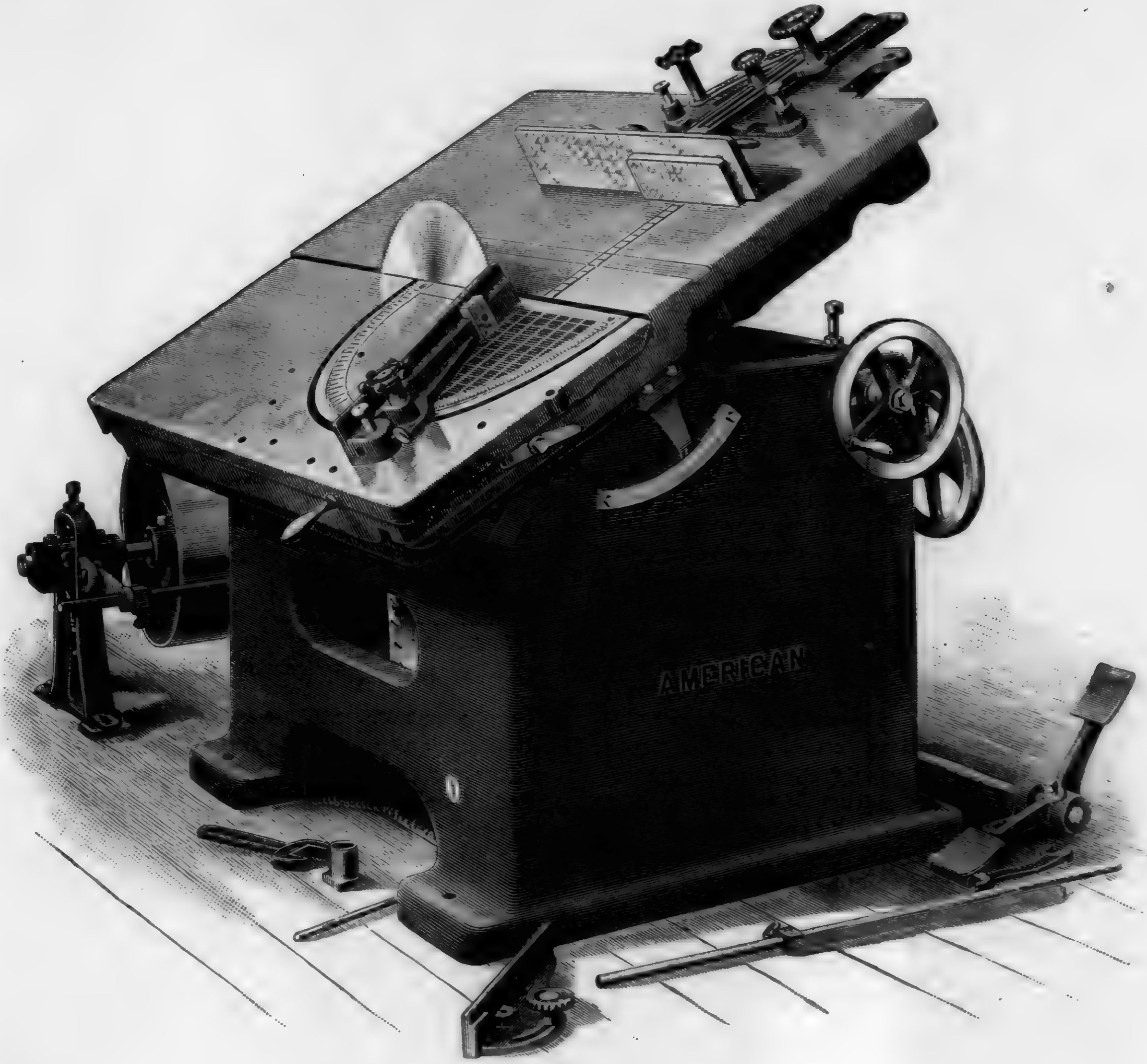
UNIVERSAL SAW BENCH.

The universal saw bench, illustrated herewith, is carefully designed for accurate cutting, and has a number of valuable improvements and attachments which enable it to turn out a great variety of work quickly and accurately. The box frame is cast in one piece, is massive and rigid, and has three points of support on the floor. The arbor yoke is extra long, and carries two cast steel arbors, $1\frac{1}{4}$ ins. diameter, with long self-oiling boxes and pulley between. The yoke swings on

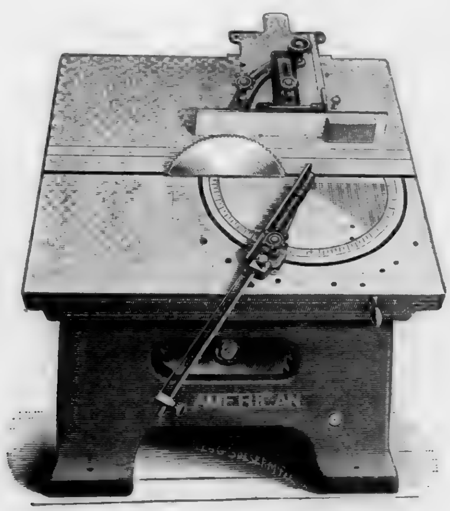


REAR VIEW WHEN TABLE IS TILTED.

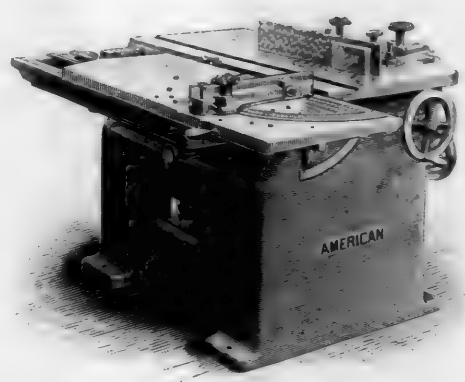
gudgeons on both sides of the saw line; the main one is 7 ins. in diameter, and has side-bearing shoulders $9\frac{1}{2}$ ins. in diameter, with a suitable adjustment for wear; the circular adjustment is by means of a heavy worm wheel and a double pitch worm, with adjustments for wear both longitudinally and laterally; thus there need be no time wasted in changing saws, and no lost motion in the connections. The table is 45 ins. long, divided into two sections; the movable left-hand one is



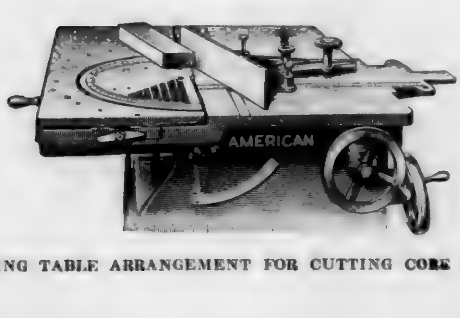
UNIVERSAL BENCH SAW.



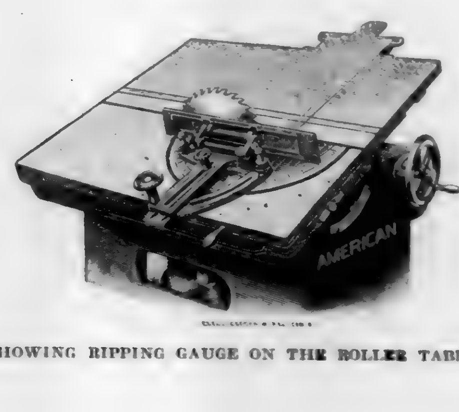
SHOWING ARRANGEMENT OF GAUGES.



FITTED WITH DADO HEAD AND SHOWING ROLLER TABLE.



SHOWING TABLE ARRANGEMENT FOR CUTTING CORE BOXES.



SHOWING RIPPING GAUGE ON THE ROLLER TABLE.

17 ins. wide and the right-hand one 22 ins. wide. The left-hand section moves on non-friction rolls, and by means of an intermediate frame or spider, it can be drawn away from the main section 2½ ins., to admit dado heads or special cutters. The entire table, which is unusually heavy and strongly ribbed, can be tilted to 45 deg., or any intermediate point, by means of a screw and radius arm, all the bearings of which can be adjusted for wear.

An accurately graduated arc and an index are provided on the front of the machine, and a stop at the rear of the frame directly in line of the radius arm holds the table, when down horizontally, square with the saw. The ripping gauge moves over the entire width of the main table, takes up to 24 ins. wide, and the fence tilts to 45 deg. from the vertical. The entire gauge also swings on one of the retaining pins to a horizontal angle with the saw, for cutting core boxes, etc. In addition to the position adjustment by means of the taper pins, there is a micrometer adjustment of 8 ins. by means of a steel rack and pinion cut from the solid, making the movement quick and accurate. The gauge may be transferred to the left-hand table when required, and there is on its face a detachable block which can be used as a cut-off stop. The cut-off or mitre gauge is swiveled on the rolling table section, and is accurately stopped by a taper pin at all the principal angles, in addition to which there is a complete half-circle protractor let into the table; to this is added a novel cross-graduated sector, by which angles corresponding to any required dimension of work can be cut without previously determining the angle, saving much time and calculation. For long work a steel rod is furnished with an adjustable end-stop, which recedes for cropping off ends, and can be used down to 2 ins. in length, and up to 5 ft. 3 ins. The right-hand table has a rule, graduated to inches and eighths for cutting off.

A supplementary cut-off gauge is fitted to the right-hand table, consisting of a long tongue, moving freely in a slot, to which is attached a swiveling head or fence, graduated to 45 deg. both ways, and arranged to be connected, when desired, with the main cut-off gauge by a yoke or arch which passes over the saw, and thus makes a long, well-supported gauge for large work. When the supplementary cut-off gauge is not in use, the fence may be detached from the tongue, and the latter turned over in its slot so as to make a flush surface on the table. A special sleeve is provided for the attachment of dado heads up to 2 ins. thick; this sleeve takes the place of the nut and loose collar on the saw arbor; heads thicker than 2 ins. at the eye will need to be recessed to receive the nut. This machine weighs complete about 2,250 lbs., and is made by the American Wood Working Machinery Company.

Largest Steel Casting.—The American Steel Foundries recently made a steel casting weighing 90,760 lbs. for the Blackwell's Island bridge at New York.

WELDING LOCOMOTIVE FRAMES WITH THERMIT.

By J. A. B. Gibson, Chief Draftsman, Richmond, Fredericksburg & Potomac Railroad.

In looking backwards within the last few years at the improvements in developing and maintaining our heavy and high-pressure locomotives, nothing has attracted the writer's attention more than the recent invention of the German scientist, Dr. Goldschmidt, and his process of welding known as the thermit process.

All mechanical railroad men know what a broken frame meant in times past, how it necessitated jacking the engine

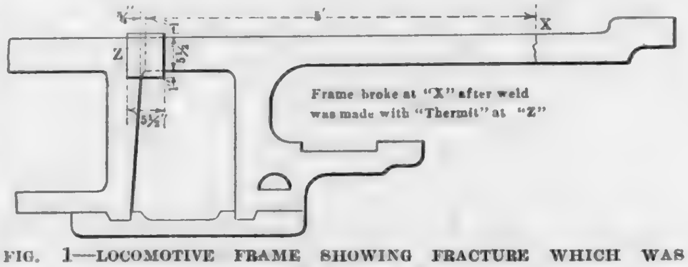


FIG. 1—LOCOMOTIVE FRAME SHOWING FRACTURE WHICH WAS WELDED BY THERMIT.

up, taking out the wheels and removing the frame to the smith shop; and even with our modern shops, equipped with electric cranes and similar conveniences, this is still an item of considerable expense, and the loss entailed in having the engine out of service often exceeds the actual cost of repairs.

This process of welding locomotive frames was recently introduced at the Boulton shops of the Richmond, Fredericksburg & Potomac Railroad, and it has proved a perfect success in welding both cast steel and wrought frames. Our first experience with a cast steel frame was on one of our large Pacific type engines. This frame broke in the top rail between the pedestals, as shown by Fig. 1.

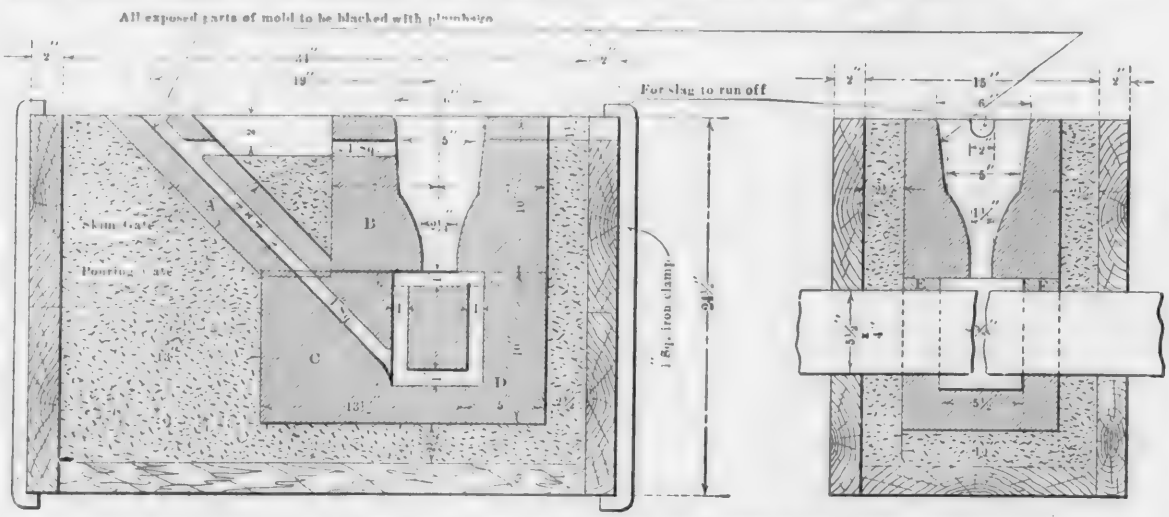


FIG. 2—MOLD USED FOR WELDING LOCOMOTIVE FRAMES WITH THERMIT.

The frame at the point of fracture was 5½ ins. deep and 4 ins. wide. After dropping the front pair of drivers and removing only that part of the spring rigging which would facilitate the work on the broken parts, the fractured ends were drawn together and the frame carefully measured, after which a number of ⅝-in. holes were drilled through the fracture and then chipped out, making a slot ⅝ ins. wide through the frame. To allow for the contraction caused by the cooling of the weld, the frame was sprung open ⅛ in. wider, making the total width of the slot ¾ in. The broken ends were then heated with a gas burner to remove all grease and dirt, and the frame was then ready to be welded.

Fig. 2 shows the mold used for welding the frame on this engine, which consisted of three parts of sharp core sand, three parts of river sand and one part of ordinary red clay. It

will be noted that the mold is in six sections; the advantages of this is that they are more easily made and placed in position. These sections are denoted on Fig. 2 by the large capital letters. The mold and also the sand surrounding the mold was thoroughly vented, to allow for the escape of gases. The mold was made to allow for a band around the frame 1 in. thick and 5½ ins. wide. To secure mold in position we used a wooden box, leaving a 3-in. space around the mold. This space being filled and rammed tightly with sharp sand. The advantages of using a wooden box are its cheapness and the rapidity with which it can be constructed and placed in position. The band was left on the frame except where it was necessary to remove it for the sake of clearance. In the case shown in Fig. 1 it was not necessary to remove any part of the band. All sections of the mold were covered with plumbago and thoroughly dried over a slow fire.

Care was taken to see that the crucible was large enough to allow for the reaction which takes place, and it was held securely in position by brackets attached to the running boards; as the vibrations caused by the reaction are liable to cause the metal to run outside the pouring gate opening and be wasted. This is of special importance when frames of high wheel engines are to be welded, as it is necessary to raise the crucible to a considerable height. The thermit was ignited with a red-hot rod, and a successful weld was made in less than one minute. After the metal had cooled sufficiently the mold was removed and the frame measured, which was found to be the original length. This frame had been in service for a number of months when it broke again 5 ft. from the thermit weld. This is shown on Fig. 1. It was necessary to remove the frame when the engine passed through the shops for repairs, but the thermit weld was not disturbed.

In making these thermit welds of both cast steel and wrought iron frames we obtained the same good results, and in no case was it necessary to hold the engines out of service more than two days. The importance of getting these engines in service so quickly was clearly demonstrated during our last busy season.

The proper amount of thermit necessary, with other information, is given in a circular published by the Goldschmidt Thermit Company. However, our experience has been that the best results are obtained by using a liberal amount of the composition mixed with 10 per cent. of small steel punchings.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—This association will hold its thirty-sixth annual convention at the Hollenden Hotel, Cleveland, September 12th to 15th inclusive. The program includes nine committee reports and topical questions. Detailed information may be secured from the secretary, Mr. Robert McKeon, Kent, Ohio.

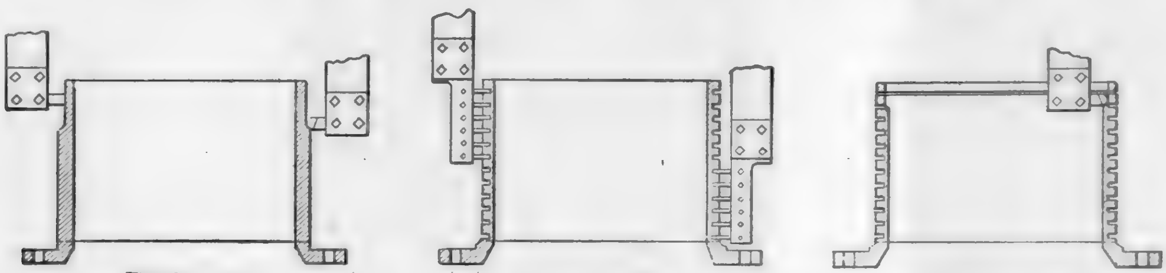
MORSE CHAIN COMPANY.—Recently an erroneous statement was printed in various journals to the effect that suit had been commenced by the "Westinghouse Interests" against the Link Belt Machinery Company. The suit in question was not brought by the Westinghouse Interests, but by the Morse Chain Company of Trumansburg, N. Y., who, on July 27th, filed bill in equity in the United States Circuit Court, Northern District of Illinois, Eastern Division, against the Link Belt Machinery Company for infringing on certain patent rights.

PRODUCTION IMPROVEMENTS.

PACKING RINGS FOR PISTONS.

Forty-eight packing rings in three hours and thirty-seven minutes, which is equivalent to 132 in ten hours, is a record made on a King 42-in. boring mill at the Washington, Ind., shops of the Baltimore & Ohio Railroad. These rings are of cast iron, ¾ x ¾ x 20½ ins. in diameter, and three operations as shown on the accompanying sketches, are required to finish them. About 3-16 ins. of material is roughed off on the inside and outside and the cutting speed for all the operations is about 52 ft. per minute.

The cylindrical casting is roughed off and finished on the outside at the same time. The next operation is to cut in the rings, and this is done with a special tool holder which is 1½ x 1¾ ins. in section and 8 ins. long, and carries 6 high speed steel cutting off tools. These tools slip into slots on the holders and are held in place by set screws. Using one of these holders in each head 12 rings may be cut in at the same time. The third and last operation is to finish the inside of the rings, at the same time cutting them off. We are indebted for this information to Mr. F. J. Smith, division master mechanic at Washington, Ind. The machine upon which this work was done was made by the King Machine Tool Company, and was described on page 60 of our February journal.



METHOD OF TURNING PACKING RINGS FOR PISTONS.

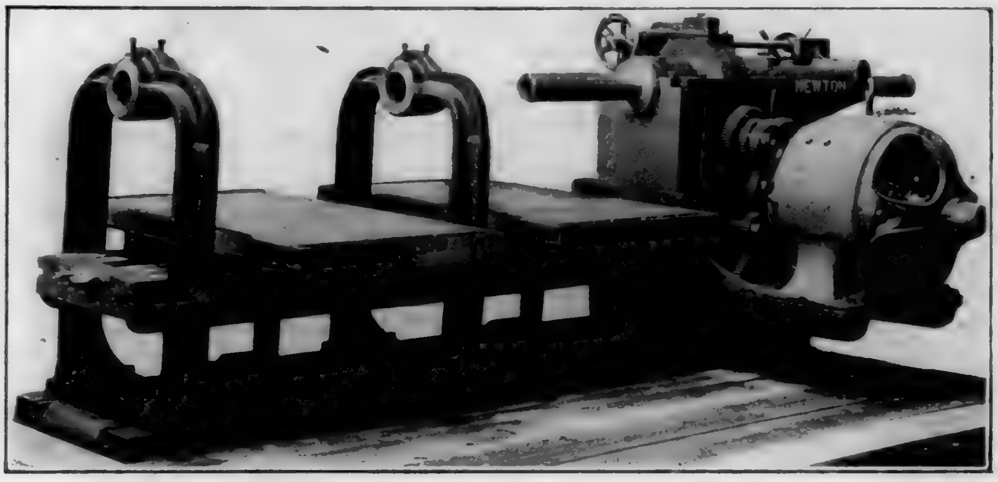
INCREASING THE MACHINE SHOP OUTPUT.—With the introduction of high-speed steel it was found on the road with which I am connected that it was possible to get an increased output if closer supervision was introduced; so in our machine shop an expert machinist was placed, whose duty it was to introduce improved methods, increasing the speed of the machinery and getting the maximum output. Each principal machine shop has an expert, and these experts visit the different shops, making reports, criticisms, recommendations and suggestions, which are taken up and discussed by the master mechanics, and the experts also meet and agree as to the methods, and universal practice which is applicable to the different shops. By the introduction of this system we have been able to increase our output very materially. We have been able to speed up our machines and increase our output to such an extent that formerly where on five pits we turned out one new engine per week we are now able to turn out two on the same pits, but, of course, we require more men to put them together.—*Mr. W. D. Robb, Canadian Railway Club.*

MASTER, THEN SHED DETAIL.—Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under you as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness, and honest dealing.—*Henry R. Towne, before Purdue students.*

HORIZONTAL BORING AND DRILLING MACHINE.

The Pennsylvania Railroad has recently installed in the Juniata shops a Newton horizontal boring and drilling machine for driving box work. Twelve boxes have been bored in one day on this machine, which is shown in the accompanying illustration, and it is expected that this will be increased to sixteen. Two boxes are set up on one end of each table and the four boxes are bored at the same time. While these are being bored four more boxes are set up ready for boring on the other end of the tables.

The spindle is 5 ins. in diameter and has a continuous positive automatic feed of 60 ins. with six changes in geometrical progression, giving a movement of from .0072 to .2646 ins. for each revolution of the spindle. The spindle also has hand adjustment and quick motion operated by hand. The spindle sleeve is driven by a phosphor bronze worm wheel and hardened steel worm which runs in a bath of oil and has a ratio of 11 to 1; the back gears have a ratio of 3 to 1, thus giving a total gear ratio of 33 to 1, with the back gears in. This drive furnishes a very smooth, steady motion to the spindle and is particularly adapted to work in which the hole to be bored is an incomplete circle, such as in driving boxes.



HORIZONTAL BORING AND DRILLING MACHINE.

The elevating knee is 9 ft. long, is raised and lowered by power and has hand adjustment. The tables are 36 ins. wide and 60 ins. long and have a cross adjustment of 36 ins. The elevating knee is 26 ins. wide and the two screws supporting it are 4 ins. in diameter. The boring bar is rigidly supported by the two yokes which are securely clamped to the base. The maximum distance from the center of the spindle to the carriage is 26½ ins. The machine is driven by a Westinghouse 10-h.p. variable speed motor with a variation of 2 to 1, and this range of speed is doubled by the back gears. The machine is made by the Newton Machine Tool Works of Philadelphia.

Limit of Speed of the Automobile.—A prominent French automobile engineer recently stated that it would not be possible for a modern racing automobile to exceed the speed of 130 m.p.h. while it is maintained at the present weight. M. Serpollet, the designer of the well-known steam car of that name, has therefore decided to approach this maximum as near as possible during this year. He is now constructing a steam car which he is confident will accomplish the kilometer in 18 seconds, or at an average speed of 125 m.p.h. The motor will develop over 200 h.p., and the weight of the engine without the steam generator or boiler will be only 330 lbs.—*Journal Franklin Institute.*

Travelling Engineers' Association.—This association will hold its thirteenth annual convention at the Cadillac Hotel, Detroit, Mich., commencing September 12th. The committee of arrangements has provided an exceedingly interesting program, and has made arrangements promising a most successful convention.

NEW LINE OF INDUCTION MOTORS.

A new line of constant speed induction motors has just been placed on the market by the Commercial Electric Company, of Indianapolis, Ind., for which the following claims are made: High power factor, large nominal breakdown factor, high efficiency at both heavy and light loads, low working temperatures, small idle currents and high starting torques. Although this company has heretofore confined its efforts to the manufacture of direct current machinery, the induction motors should not be regarded as experimental, as they have been carefully designed by engineers who for years past have been engaged in designing alternating current machinery for European manufacturers.

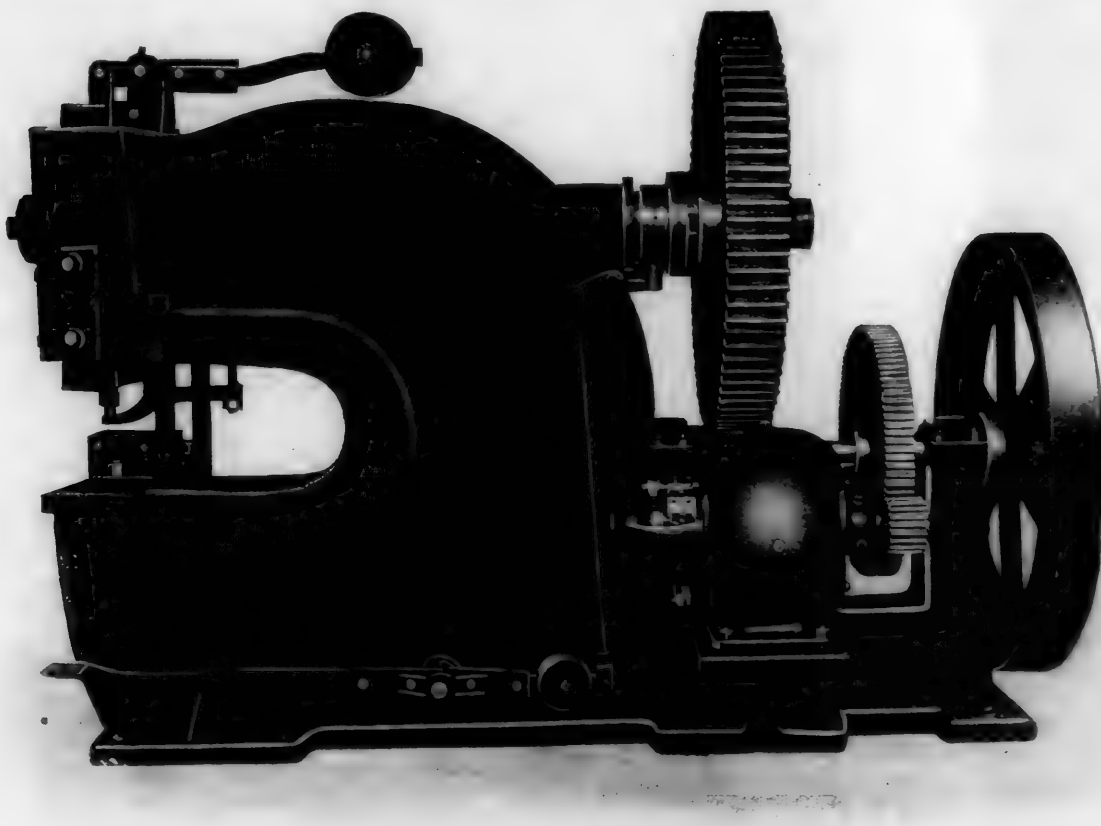
To produce a high power factor in these machines it is necessary to have a limited clearance between the external diameter of the rotor and the internal diameter of the stator. The design of the stator frame and head is such that an equal division of this clearance is always secured and maintained. A very large bearing is provided for the rotor shaft in order to reduce the wear to a minimum. The bearings are self-oiling and self-aligning, and are arranged so that the machines may be inverted if desirable. The linings of the bearings are interchangeable, so that the replacement of the bearings is simple and inexpensive. The shafts are of large diameter, and the distance between the bearings is reduced to a minimum in order to make them as rigid as possible. The rotors are forced on the shaft by hydraulic pressure. To insure cool operation ventilating apertures are provided across the faces of the stator and rotor cores. The starting device used with these machines is such that the starting current is practically reduced to that used with direct current motors of corresponding capacity. These motors are made in all standard sizes, voltages and frequencies and in both two and three phases, in 25 and 60 cycles.

NEW INDUCTION MOTOR.

Electric Motors and Wood Working Machinery.—So far, I feel very much in favor of the D. C. transmission for machine shops. I am not talking from the point of view of the car department, although it does seem a pity that we cannot get a firm of car machinery making people to bring along motors that we can put on wood machines, instead of having the mass of belts as at present. I do not think there should be much trouble in getting an A. C. motor running 3,600 r.p.m. which would give us a motor on our wood machines. The belting is a large item in a wood mill.—*Mr. H. H. Vaughan, Canadian Railway Club.*

IMPROVED MOTOR DRIVEN PUNCH.

The illustration shows an improved Cincinnati punch equipped with the positive automatic stop and new sliding clutch which were illustrated and described in detail in our February journal, page 65. The adjustable stop allows the machine to be automatically stopped at any desired part of the stroke, and is especially valuable for exact center punching where it is desirable to have the tool stop close to the work. The section of the driving shaft upon which the clutch slides is square, thus doing away with the use of feathers or keys, and as the distance across flats is the same as the diameter of the round portion of the shaft the strength is considerably increased at what is ordinarily its weakest point.



IMPROVED CINCINNATI PUNCH.

The frame is of a heavy box section, with the walls extending considerably above the center of the driving shaft, thus making it very rigid. The sliding head is made extra long, with large bearing surfaces. The machine illustrated has a depth of throat of 24 ins., and will punch a 1-in. hole through 1 in. The lower jaw, which is used for standard punching, and also affords ample seat for the shear blocks, may be removed, and flange work may be done with a combination block. The motor is mounted upon a substantial cast iron bracket, and drives the machine through cut gears. These punches are made by the Cincinnati Punch & Shear Company, Cincinnati, Ohio, with depth of throat from 12 to 36 ins., single or double, and adapted for either belt or motor drive.

The Government Wants a Draftsman.—Civil Service examinations will be held September 13th and 14th for a vacancy in the position of architectural and structural draftsman, at $1,500 per year, in the Quartermaster's Department at Large, Washington, D. C. At the same time examinations will be held for constructing engineer for sewer and water works at Manila, Philippine Islands. Several men are wanted. Salaries ranging from $1,400 to $2,000 per year. Information concerning these examinations may be had from the United States Civil Service Commission, Washington, D. C.

ROUNDHOUSE HEATING AND VENTILATION.

In discussing locomotive terminal facilities before the Master Mechanics' Association Mr. H. H. Vaughan said, in part:

As far as heating and ventilating is concerned, I have had considerable experience both on the Lake Shore and the Canadian Pacific, and with the type of heating arrangement put in at Elkhart, the direct steam heating system (see American Engineer, February, 1905, page 42, and March, page 80). A few years ago on the Lake Shore we equipped a total of 16 roundhouses with that arrangement, and for six years on the Canadian Pacific road we have heated eight roundhouses by this system, and in all cases the results have been most satisfactory. We have not only been able to warm the houses, but we have done it at a saving in the coal consumed for heating over that which was used in previous years, the saving in coal alone being sufficient to justify the cost of putting in the heating plant, which I consider a very satisfactory result. The Elkhart roundhouse was constructed with a definite end in view. That was that the cold air, entering under the doors, would be warmed by the pipes in the pit, and as the air ascended to the roof of the house it would carry with it the steam and smoke so common in roundhouses. That idea, I think, has been amply carried out in practice, and I feel very strongly that that form of house is the best cross-section of house that has so far been devised if we want to keep the house clear of smoke and steam. At the last convention, when we had a topical discussion on this subject, I mentioned that we were going to inclose the turn-table in the house. While that plan has been moderately successful, it has not been entirely so. The house we inclosed was heated with hot air in place of direct radiation, and the troubles that are so frequently met with in hot air heating were very much accentuated in the closed house—that is, the drawing back of the smoke through the heat fan and being thoroughly mixed with the air and driven out again, so that the whole house is filled, not with smoke that is opaque, but with smoke which affects the eyes and lungs of the men. I feel that if the house had

been heated with direct radiation, so that in place of having a horizontal circulation of air we should have obtained a vertical circulation of air, that we should have had a successful house. The horizontal circulation of air which you get in a house heated with hot air is extremely troublesome unless the ventilation is first-class. There is a tendency to draw the smoke into the fan. The hot air people tell us we can correct that by taking in more outside air, which is perfectly correct; but if we take in more outside air we run up the expense of heating the air very rapidly. All the cold air coming in has to be warmed up to the temperature of the house, in place of having to be kept warm, and in a cold climate that is impracticable on account of the expense. After an experience which we have had in the last two years I agree that the system of heating and ventilation of roundhouses suggested in the report is probably the best, and I believe that system will avoid nearly all of the smoke and steam troubles provided one thing is attended to, and that is the proper height of jack and ventilator. We found that a short jack and short ventilator did not relieve the smoke trouble. We are now putting in ventilators 20 or 25 feet high, in order to get a good vertical draft through them.

PERSONALS.

Mr. Edgar Shellabarger has been appointed master mechanic of the East Broad Top Railroad at Orbisonia, Pa.

Mr. H. F. Smith has been appointed car foreman of the Lake Shore & Michigan Southern Railway at Collinwood, Ohio.

Mr. F. W. Williams, master mechanic of the Delaware, Lackawanna & Western at Buffalo, N. Y., has resigned.

Mr. E. G. Bryant has been appointed master mechanic of the International & Great Northern at Mart, Texas.

Mr. C. M. McLain has been appointed master mechanic of the International & Great Northern at Taylor, Texas.

Mr. A. P. Prendergast has been appointed assistant master mechanic of the Mt. Clare shops of the Baltimore & Ohio.

Mr. G. O. Hammond has been appointed mechanical engineer of the Erie Railroad at Meadville, Pa., succeeding Mr. A. G. Trumbull, promoted.

Mr. J. Kirkpatrick has been appointed master mechanic of the Baltimore & Ohio at Cumberland to succeed Mr. T. R. Stewart, promoted.

Mr. J. B. Elliott has been appointed master mechanic of the Baltimore & Ohio Railroad at Newcastle Junction, Pa., to succeed Mr. J. Kirkpatrick, transferred.

Mr. H. P. Hunt, assistant mechanical superintendent of the Erie Railroad at Meadville, Pa., has resigned, to enter the service of the American Locomotive Company.

Mr. E. E. Crysler has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Railroad at Indianapolis. Ind., to succeed Mr. J. W. Connaty, resigned.

Mr. T. R. Stewart, master mechanic of the Baltimore & Ohio at Cumberland, Md., has been appointed master mechanic of the Philadelphia, Baltimore & Shenandoah divisions of the Baltimore & Ohio.

Mr. A. G. Trumbull has been promoted from the position of mechanical engineer of the Erie Railroad at Meadville, Pa., to that of assistant mechanical superintendent, succeeding Mr. H. B. Hunt, resigned.

Mr. G. Willius, Jr., has been promoted from the position of assistant mechanical engineer to that of mechanical engineer of the Great Northern Railway to succeed Mr. R. D. Hawkins, promoted.

Mr. H. A. Child, formerly master mechanic of the Erie Railroad at Jersey City, has been appointed superintendent of motive power of the Guayaquil & Quito Railway in Ecuador.

Mr. H. P. Meredith has been appointed engineer of motive power of the Pennsylvania Railroad at Jersey City, succeeding Mr. Elliott Sumner. He was formerly assistant master mechanic at Altoona.

Mr. Elliott Sumner has been appointed engineer of motive power of the United Railroads of New Jersey division of the Pennsylvania Railroad, being promoted from the position of assistant engineer of motive power.

Mr. Thomas J. Tonge has been appointed master mechanic of the Zuni Mountain Railway at Thoreau, Mexico. He has heretofore been roundhouse foreman of the Atchison, Topeka & Santa Fe Coast Line at Winslow, Ariz.

Mr. T. E. Adams has been appointed superintendent of motive power in charge of all rolling stock, locomotives and machinery of the St. Louis, Southwestern, with headquarters at Pine Bluff, Ark. Heretofore his title has been general master mechanic.

Mr. Charles J. Donohue, chief clerk of the motive power department of the Lake Shore & Michigan Southern, has been made secretary to the general manager at Cleveland, to succeed Mr. F. E. Woodruff, assigned to other duties. Mr. Donohue has been chief clerk of the motive power department for a number of years.

Mr. G. M. Dow has been appointed general mechanical inspector of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, Ohio. Mr. Dow has been master car builder for a number of years. The duties of the master car builder at Collinwood have been assumed by Mr. S. K. Dickerson, master mechanic, and Mr. M. D. Franey, superintendent of shops at that point.

BOOKS.

Steam Engineering. A Treatise on Boilers, Steam, Gas, and Oil Engines and Supplementary Machinery. By W. W. F. Pullen. Published by the Scientific Publishing Co., Manchester, England. Price, 4s.

This work opens with a synopsis of mechanical laws and definitions, followed by descriptions of the construction of steam turbines, steam engines and boilers. It includes chapters on measuring pressure power and work, the measurement of heat, descriptions of auxiliary machinery, valves and internal combustion engines. The scope is large and in the hands of a class directed by a competent instructor a very general idea of the subject may be obtained. Twelve pages only are devoted to the locomotive.

Practical Perspective; by Richards-Colvin; published by the Derry-Collard Company, 256 Broadway, New York.—This pamphlet of 60 pages clearly presents the principles of isometric perspective, which the author considers the only practical perspective for mechanical work. The second part of the book presents a large number of illustrations for the use of perspective paper for making rapid sketches; this includes architectural details, lathe work, locomotive details and a number of convenient applications. The object of the book is to show the practical value of isometric perspective by removing the difficulties which have prevented its wider use. The Derry-Collard Company sends a copy of the book and two pads of the isometric sketching paper for $1.

Basis of Railway Rates and Private vs. Governmental Management of Railroads. By Marshall M. Kirkman. Published by the World Railway Publishing Co., 79 Dearborn Street Chicago, 1905. Price, $2.50.

This book is a reprint in part, of a work by the same author which appeared several years ago. It is specially opportune just now, because of the general interest in rate making and the popular demand for governmental control of rates. The author shows that since 1863 rates per ton mile have dropped from 3.642 to 0.763 cents. From this the public received a dividend of 42.9 per cent. on the total cost of the railways of the country, whereas the bonds brought a return of only 3.74 per cent. He says, "The truth is that air and water do not adjust themselves more naturally than

... rates of railways adjust themselves to the vicissitudes of ...dle. If there are exceptions the evil contains its own cure, ... so does not invite statutory enactments." The book elaborates ... theory and practice of rates from the standpoint of a rail... official of many years of experience.

...ectrician's Handy Book. By T. O'Conor Sloane. A modern work of references, a compendium of useful data, covering the field of electrical engineering. 761 pages, 4½ by 6½ ins. in size, with 556 illustrations. Published by the Norman W. Henley Company, 132 Nassau street, New York. Price, $3.50.

This convenient book treats of the theory of the electric cur...nt, circuits; electro chemistry; primary batteries; storage bat...ries; generators and utilization of electric power; alternating ...rrent; armature winding; dynamos; motor generators; central ...tion operation; switchboards; lighting; electric measurements; ...ectric railways; telephony, and wireless telegraphy. The work ...ves in simple, compact, yet comprehensive form, a great deal of ...escriptive information concerning electrical machinery, its con...ruction and its use. It is a very convenient handbook, and is ...vidently intended specially for those who do with the operation ...f power stations. Its field, however, is much larger than this, ...nd many not having to do directly with electrical machinery will be very glad to have the book within reach for ready reference. The publishers are to be complimented upon the letter press, the index and specially clear engravings.

CATALOGS.

INDUCTION MOTORS.—Circular No. 200 from the Commercial Electric Company, Indinnapolis, Ind., describes their new line of induction motors.

SHAPERS AND GRINDERS.—Catalog D from the Cincinnati Shaper Company, Cincinnati, Ohio, describes their shapers of pillar, column and traverse types and their new line of traverse grinders.

FROGS, SWITCHES AND CROSSINGS.—Catalog A from the Weir Frog Company, Cincinnati, Ohio, is devoted to light rail work for use in tracks of electric roads, coal mines, plantations and factories.

NORTHERN SPHERICAL MACHINES.—The new bulletin No. 50 of the Northern Electrical Manufacturing Company describes their spherical dynamos and motors. These are shown in a large variety of applications, including a number of machine tool drives.

THE JANITOR AND THE LIBRARIAN.—Another one of those characteristic little pamphlets from the Lucas Machine Tool Company, of Cleveland, O., concerning the advantages of the Precision boring, drilling and milling machine and their power forcing press.

ELECTRIC CONTROLLERS.—Circular No. 1108 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to a description of the Westinghouse regulating and reversing controllers. Applications of these controllers to machine tools, cranes and elevators are shown.

FLANGED PIPE JOINTS.—The Crane Company, of Chicago, have issued a treatise concerning the merits of the various styles of joints used in attaching flanges of wrought pipe; these include screw joints, "Crane lap," "Crane weld," shrunk, riveted and rolled joints, with comments upon the merits of each.

ELECTRICAL APPARATUS.—Bulletin No. 60 from the Crocker-Wheeler Company, Ampere, N. J., contains a description of their small direct current motors, ¼ to 3 h.-p., and illustrates several interesting applications to machine tools. Bulletins Nos. 56 and 57 describe their generating sets with Case and Forbes engines.

ALTERNATING CURRENT THREE PHASE TRACTION.—An elaborate publication issued by the Railway Electric Power Company, New York, setting forth the characteristic features and advantages of the Ganz three phase alternating current traction system, with special reference to the results obtained from its three years' use abroad.

ELECTRIC MOTORS AND TRAILER TRUCKS.—The Baldwin Locomotive works in their Record Of Recent Construction No. 50, illustrate thirteen motor and trailer trucks for electric railway service, each page illustrating a truck being accompanied by a page containing descriptive information. The pamphlet is in the usual attractive form of the Baldwin publications.

STEAM TRAPS.—Catalog from the Youngstown Steam Trap Company, Keystone Bank building, Pittsburg, Pa., describing the Youngstown steam trap.

SOFT WATER.—The Kennicott Water Softener Company, Railway Exchange, Chicago, Ill., have issued a handsome pamphlet presenting a reprint of the articles on "Water Softening" on the Pittsburg & Lake Erie Railroad, which appeared in this journal in January, February, March and April of this year, by G. M. Campbell, electrical engineer of the road.

GAS PRODUCERS.—The Morgan Construction Company, Worcester, Mass., has issued a very complete and handsome catalog, describing the construction and considering at length the operation and advantages of the Morgan continuous gas producer. Details of a test made by Robt. W. Hunt & Company are given, showing an average efficiency of 92 per cent.

AIR BRAKE LUBRICATION.—The Joseph Dixon Crucible Company, of Jersey City has issued a little pamphlet devoted to the subject of air brake lubrication and the application of graphite in air brake practice. The opinion of Professor Goss as to the efficacy of graphite on air brake triple valves, as reported to the Master Car Builders' Association, is quoted, and the desirability of graphite for this purpose is fully shown. The pamphlet includes directions for the use of this lubricant for triple valves, brake valves, brake cylinders, pistons and air pumps. Abundant testimony is furnished by the records of discussions before the railroad associations and by articles in the railroad papers of the necessity for improving the lubrication of the moving parts of the air brake. This pamphlet should be brought to the attention of all who are responsible for the operation and maintenance of air brake practice on all railroads.

NOTES.

An announcement of the sudden death of Mr. Frederick Schurchman, vice-president and general manager of the Homestead Valve Manufacturing Company, has been received. His death occurred July 25th at Homestead, Pa.

INDEPENDENT PNEUMATIC TOOL COMPANY.—Mr. Charles Parsons, of Chicago, has become associated with this company. Mr. R. S. Cooper, formerly with the Rand Drill Company, has been appointed manager of the New York office at 170 Broadway.

PRATT & WHITNEY.—This company has made arrangements with the C. T. Patterson Co., Ltd., of New Orleans, La., to represent their small tool department in the Southwest territory. The Patterson Co. have a very complete line of small tools, and are in a position to fill orders from their New Orleans establishment.

S. F. BOWSER & COMPANY.—Mr. William T. Simpson, formerly with the Detroit Lubricating Company and more recently with the American Locomotive Equipment Company, has accepted a position with S. F. Bowser & Company, of Fort Wayne, Ind., manufacturers of the Bowser oil storage systems and oil house equipments.

A. C. STILES ANTI-FRICTION METAL COMPANY.—Mr. Henry W. Toothe has resigned his position as manager of the railway department of the Magnolia Metal Company, and has accepted a position as manager of the Babbitt Department of the A. C. Stiles Anti-Friction Metal Company, of New Haven, with headquarters in New York City.

CHICAGO PNEUMATIC TOOL COMPANY.—The semi-annual statement of the financial condition of this company shows total profits for the half year of $413,941.54. The amount available for dividends is $273,736.52, and the balance carried to surplus $151,460.86. The surplus carried forward is $376,898.17, showing a very successful half year.

THE STERLING EMERY WHEEL COMPANY.—This company has moved its store in Chicago, Ill., from 65 S. Canal street to 30 and 32 S. Canal street, the building at the former location having been badly damaged by fire in July, 1905. The managers of the Chicago store will be glad to receive trade papers and catalogues of all kinds of machinery pertaining to their line.

NEW JERSEY TUBE COMPANY.—This company, of Newark, N. J., announces that the Maine Central has specified their spirally corrugated boiler tubes on all the new engines recently ordered.

CROCKER-WHEELER COMPANY.—The Proctor & Gamble Company have ordered a 200-k.w., three phase, 60 cycle engine type alternating current generator for their Ivorydale, Ohio, lighting and power plant. This is a duplicate of the first alternator ever built by the Crocker-Wheeler Company, which was installed at the Proctor & Gamble Company plant at Atlanta ten months ago.

KRIPS-MASON MACHINE COMPANY.—This company of 1636 North Hutchinson street, Philadelphia, Pa., exhibits a cutting and punching machine at the Lewis and Clarke Centennial Exposition at Portland, Ore. These are the only Eastern manufacturers of punching and cutting machinery exhibiting. They also distributed samples of washers of metal and fibroid cut by their machines.

WM. B. SCAIFE & SONS COMPANY.—The Midland Steel Company, Pittsburg, Pa., who are to erect a large blast furnace plant at Midland, Pa., have placed contract with Wm. B. Scaife & Sons Company, Pittsburg, Pa., for six steel frame buildings; also crane-runways and other steel work. A very large tonnage of structural shapes and plates will be required in this connection.

THE D. T. WILLIAMS VALVE COMPANY.—This company has just arranged for the exclusive manufacture and sale of the Cookson steam trap and separator, formerly manufactured by the Cookson Steam Specialty Company. This steam trap is very well known throughout the country. It is extremely simple and accessible. A twelve-page pamphlet will be sent upon request to the D. T. Williams Valve Company, 904 Broadway, Cincinnati, Ohio.

LOCOMOTIVE APPLIANCE COMPANY.—At the annual meeting held in Chicago, August 10th, the following directors were elected for the ensuing year: Messrs. J. H. McConnell, Pittsburgh, Pa.; E. B. Lathrop, Frank W. Furry, Ira C. Hubbell, J. B. Allfree, Willis C. Squire, J. J. McCarthy, of Chicago; W. J. McBride, Clarence H. Howard, B. F. Hobart and C. A. Thompson, of St. Louis, Mo. Mr. McConnell was elected to take the place of Dr. G. W. Cale, Jr., resigned.

GEORGE H. GIBSON & COMPANY.—Mr. H. P. Gillette, formerly associate editor of *Engineering News*, and Mr. George H. Gibson, formerly manager of publicity for the International Steam Pump Company, have formed a partnership as "advertising engineers," under the name of George H. Gibson & Company, with offices in the Park Row building, New York. They are organized to undertake a firm's advertising in the same manner as would a department in the firm's own offices. Both of these gentlemen are prepared to render valuable service because of their training and experience.

THE MORSE CHAIN COMPANY.—This company, located at Trumansburg, N. Y., are now building at Ithaca, N. Y., a plant of about five times the present capacity. The company was incorporated in 1898, no change having been made either in the name or personnel since starting, Mr. F. L. Morse being the treasurer and general manager. The plant was originally started for the manufacture of bicycle chains, but in 1901 they brought out the present high-speed, silent running chain, and since that time have had a rapidly growing business. In the line of power transmission the Morse Company have in service chains transmitting over 75,000 h.p., and are furnishing drives up to 500 h.p. for a single transmission.

SEARCHLIGHT PUBLISHING COMPANY.—Mr. W. M. Probasco announces that he has become associated with Mr. E. G. Handy and Mr. W. G. Jordan in the publication of the "Searchlight." This company has four departments comprising one for the publishing and advertising interests of important mechanical manufacturers, engineering firms and railroads; one for the publication of the "Searchlight," keeping up-to-date the "Searchlight Information Library" and the publication of books. The "Searchlight" is a condensed, classified and up-to-date history of the 20th century, issued weekly, covering sixty separate departments. It is intended that nothing of real importance shall escape its editors. The four branches of the business of this company constitute a very large undertaking, with which the gentlemen concerned are fully capable of coping.

AMERICAN BLOWER COMPANY.—Mr. J. R. McColl, a man of high standing in his profession, who was until the close of the last college term associate professor of steam engineering at Purdue University, has decided to take up commercial lines and has accepted a responsible position in the engineering department of the American Blower Company at Detroit, Mich. The National Tube Company has placed a large and important order, for immediate execution, with the American Blower Company. The contract embraces complete heating equipment for their five new butt weld mills at Lorain, Ohio.

MELTING SNOW FROM LOCOMOTIVES.—Not long since, ten existing stalls in the roundhouse of the N. Y., O. & W. R.R. Co., at Middletown, N. Y., were equipped by the B. F. Sturtevant Company, of Boston, Mass., with a system of heating and ventilation particularly designed to rapidly remove the snow and ice from the running gear of the locomotives during the winter season. This house has recently been doubled in size, making twenty stalls in all, with ¾ of a million cu. ft. of space. It is stated that during the past winter when the thermometer was from 5 to 20 deg. below zero, engines could be thawed out in from one to two hours, although completely covered with snow. In the old roundhouse which this superseded, and in which the pits were equipped with steam pipes, it required from five to six hours to accomplish the same result.

VERTICAL VARIABLE SPEED MOTORS.—These motors enable the machine designer to do away with the necessity of turned belt, beveled gears, etc. The equipment makes the driven machine far more compact in arrangement, and, of course, secures far greater economy of operation than is possible by ordinary means of power transmission. The Northern Electrical Manufacturing Company, Madison, Wis., has paid special attention to the development of vertical motors, and in the design eliminates all of the troubles due to lubrication of a vertical armature shaft. These motors are extensively employed in all fields of work. Where required the Northern single voltage system is applied to the vertical motors, thus making it possible to operate the driven machine at the speed best suited to the requirements of the work. Simple controlling devices are used with this system, and the motors operate from any ordinary two wire single voltage direct current circuit.

THE BUFFALO FORGE COMPANY.—The Erie Railroad has awarded to the Buffalo Forge Company the following contracts: Heating and ventilating outfit for the 42-stall roundhouse at Buffalo, requiring a 220-in. fan belted to a 75-h.p. motor, and a heater containing 15 four-row sections, each section being 6 ft. by 8 ft. 4 ins. A heating and ventilating outfit for the 43-stall roundhouse at Hornellsville, N. Y., requiring a 210-in. fan belted to a 60-h.p. motor, and a heater containing 20 two-row sections, each section being 7 ft. by 9 ft. 4 ins. Another outfit for the 21-stall roundhouse at Galion, Ohio, requiring a 150-in. fan driven by an 8 by 10-in. Buffalo engine, and a heater containing 10 four-row sections, each section being 5 ft. by 6 ft. 10 ins. And, fourth, a heating and ventilating outfit for the 21-stall roundhouse at Huntington, Ind., requiring a 150-in. fan driven by an 8 by 10-in. Buffalo engine, the heater containing 12 four-row sections, each section being 5 ft. by 6 ft. 10 ins. The pipe alone used in these heaters, if laid continuously, would cover a distance of almost 6½ miles.

DEPENDABLE HYDRAULIC JACKS.—Unless a hydraulic jack is absolutely reliable, the engineer, mechanic, railroad man or whoever is using it, is better without it. Just at the critical moment, when everything depends on a jack "standing up," a poorly made device is liable to give away. The consequences are best left to the imagination, they are not pleasant, even to imagine. In the Watson-Stillman hydraulic jacks, every such element of uncertainty is eliminated, hence the confidence reposed in them by those who have to trust life and limb to the dependability of a hydraulic jack. The cylinders and rams, for which, in some makes, so-called seamless tubing is thought good enough, are in the Watson-Stillman jacks forged from solid steel billets, forged and bored like the cylinder of a high-class steam engine. Valves, glands, pistons, etc., are made and finished with equal care, packings and other parts subject to wear are easily accessible and replaceable, the result being a hydraulic jack so thoroughly dependable and constantly ready for service, that it holds first place among this class of tools. The manufacturers, Watson-Stillman Company, 46 Dey street, New York, have a list of about 300 styles of hydraulic jacks, which they will send on request.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

OCTOBER, 1905.

CONTENTS.

COMMON STANDARD LOCOMOTIVES.

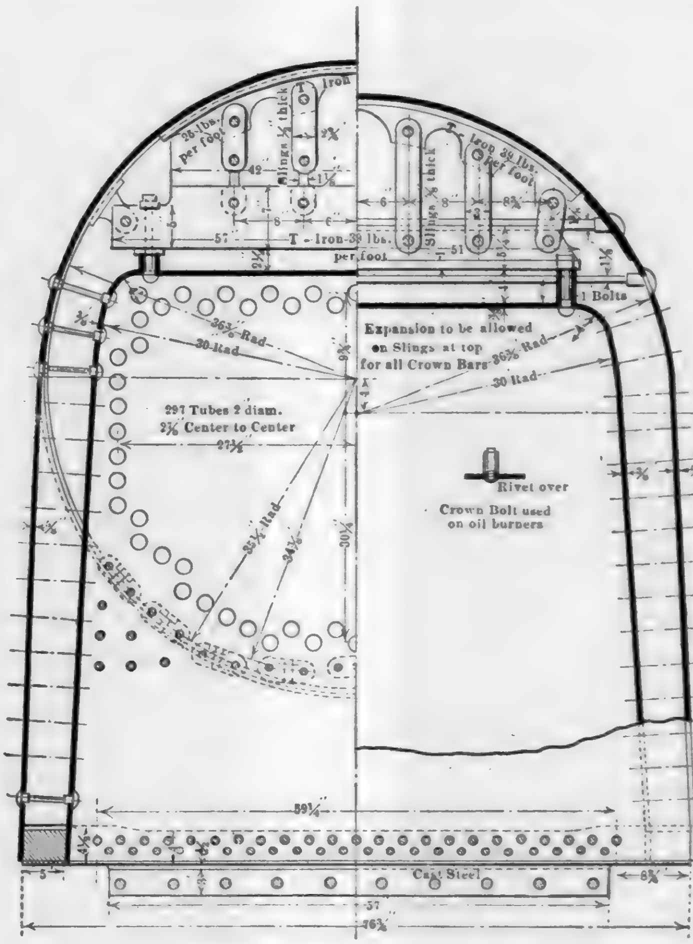
HARRIMAN LINES.

VI.

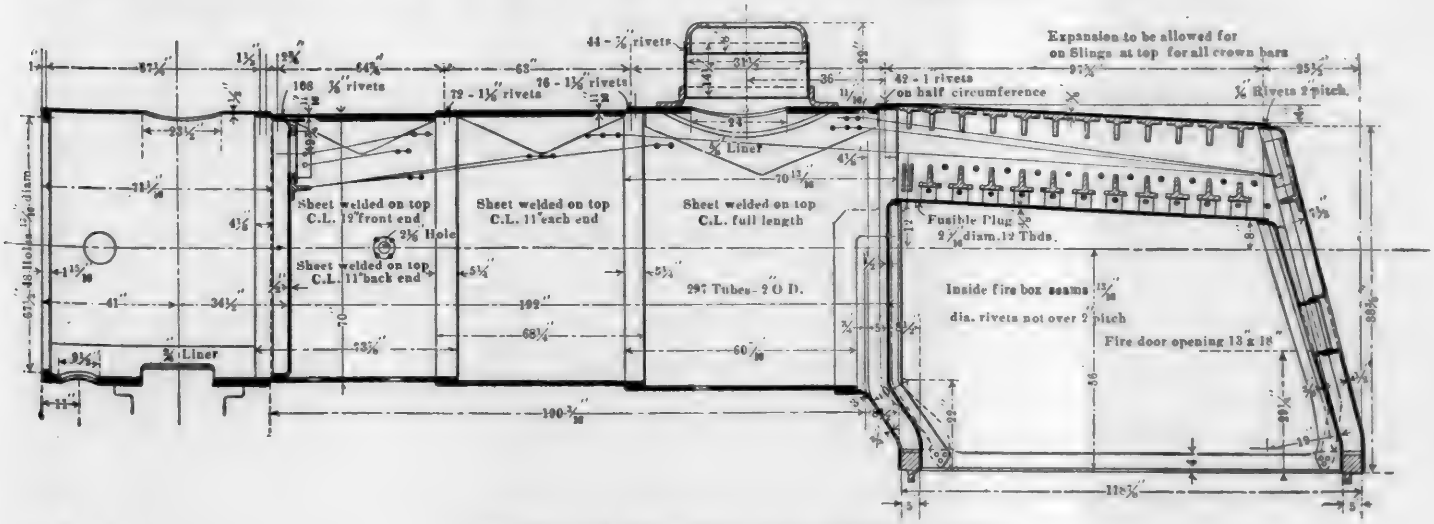
(*For previous articles see pages* 154, 200, 250, 288 *and* 322.)

The general dimensions of the boilers were given in the table in the May number of this journal, page 154, which indicates that there are but two sizes of boiler barrels, all of which are 70 ins. in diameter outside of the first ring, except the boilers of the consolidation locomotives, which are 80 ins. in diameter. The three designs of the road engines have the same size firebox, viz., 108 ins. long by 66 ins. wide. All have the same grates and the same grate casting was applied in all with somewhat different shaking rigging for the different types. An important item in this boiler construction is a water space of 5 ins. all around the fireboxes of the road engines. The water spaces for the switcher firebox are 4 ins. in front and 3½ ins. at the sides and back.

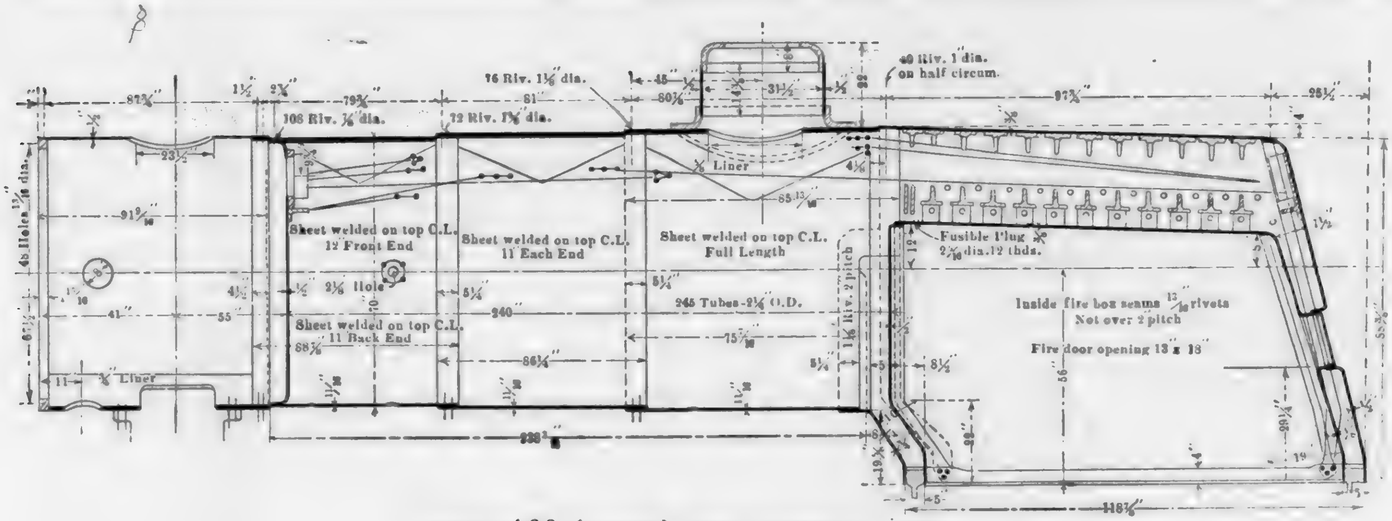
The fireboxes of the Atlantic and Pacific types are exactly alike, the chief differences between these boilers being in the length. All of the mud rings are of cast steel, 5 by 4 ins. in section and reinforced at the corners. They are all double



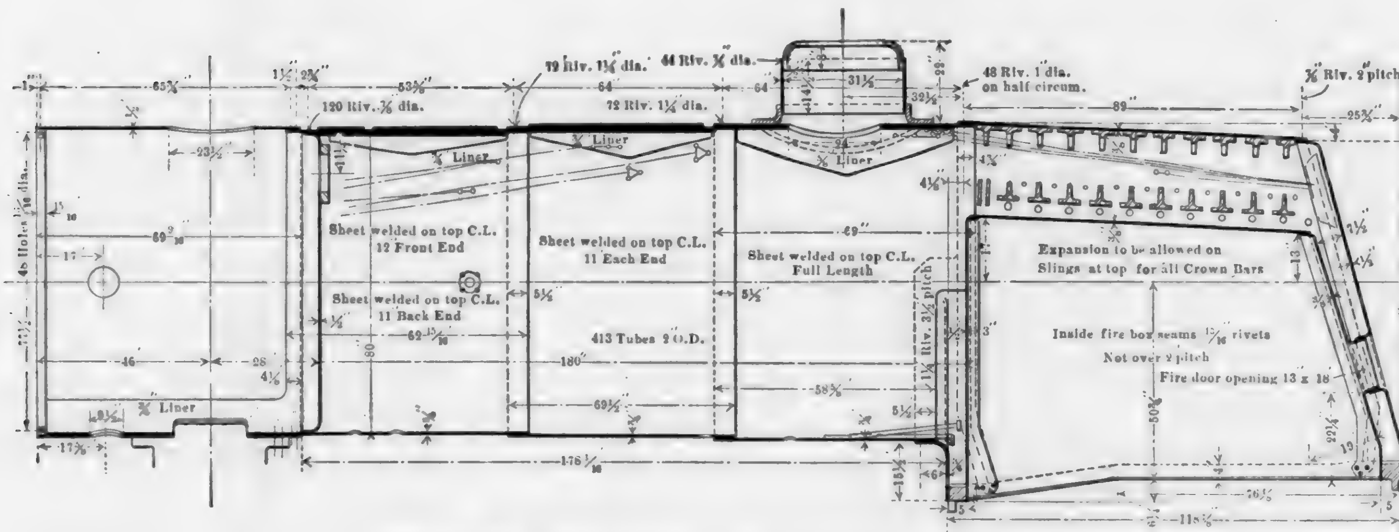
CROSS-SECTIONS THROUGH FIREBOX.



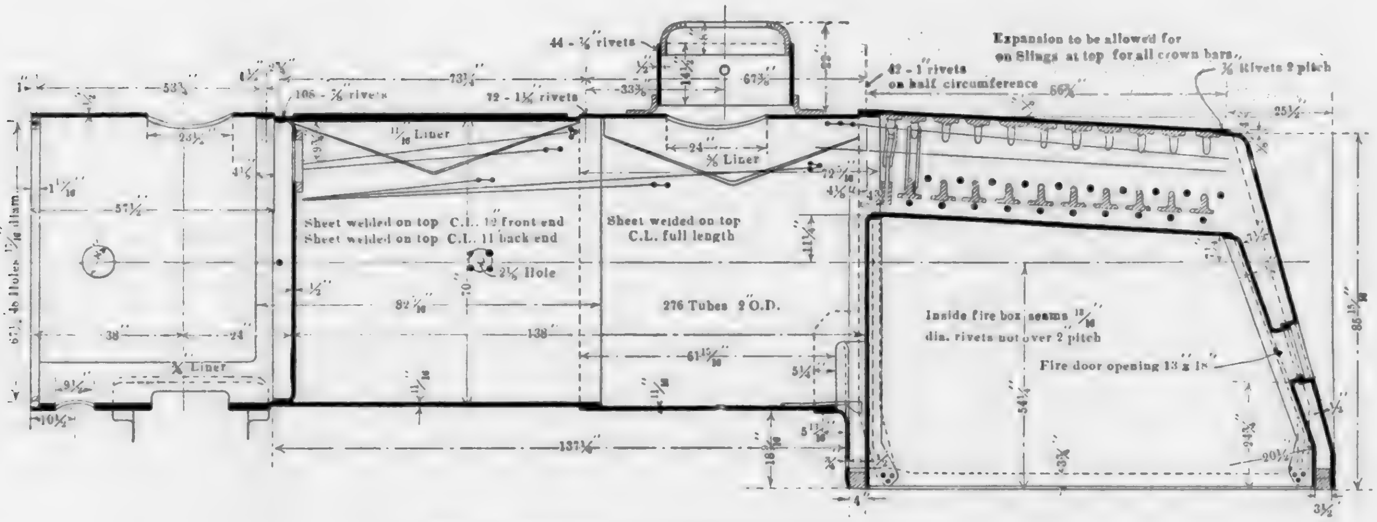
BOILER—4-4-2 (ATLANTIC) TYPE—HARRIMAN LINES.



BOILER—4-6-2 (PACIFIC) TYPE—HARRIMAN LINES.

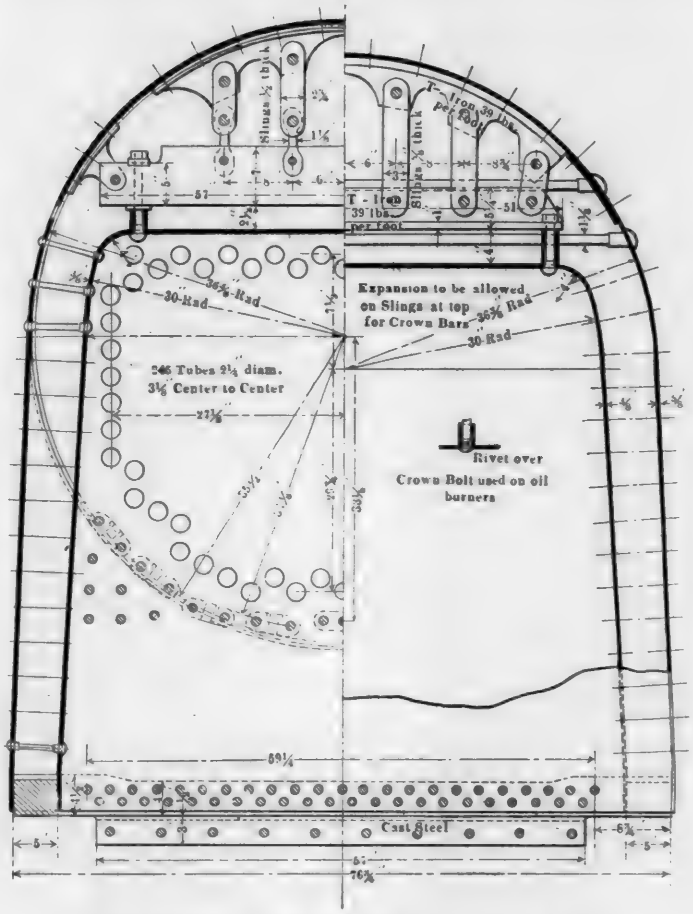


BOILER—2-8-0 (CONSOLIDATION) TYPE—HARRIMAN LINES.

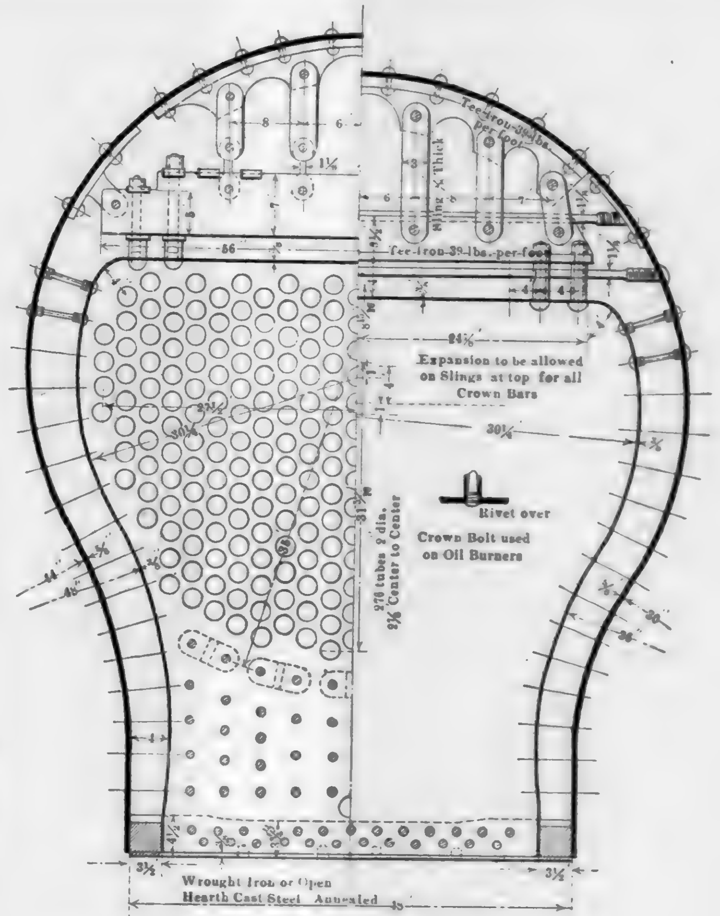


BOILER—SWITCHING LOCOMOTIVES—HARRIMAN LINES.

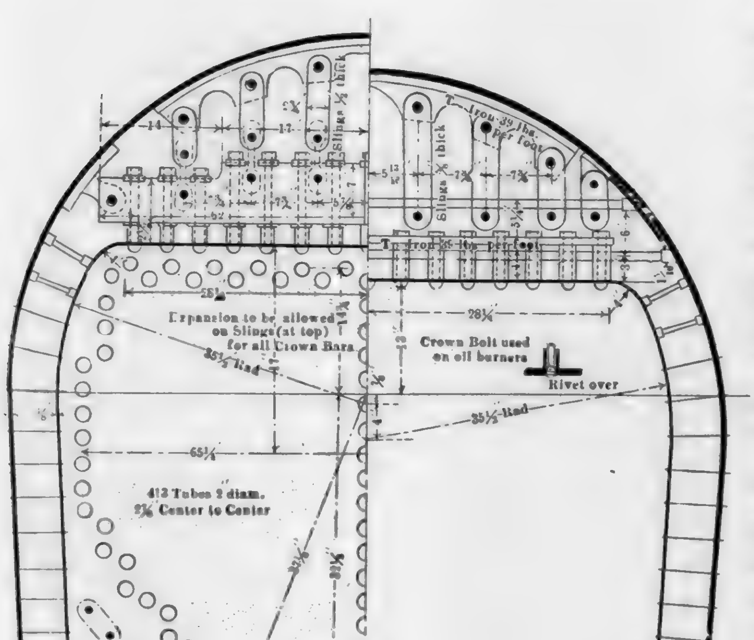
riveted. In all of the boilers the crown sheets are supported by T iron crown bars attached by slings to T iron roof bars which are continuous through the crown; that is to say, there is no break in the center. All the crown sheets are flat and all the boilers are straight top, except as the fireboxes slope towards the rear. The sheets are telescopic in all the designs. The circumferential seams are double riveted. The diamond welt horizontal seams are known as the Vauclain diamond boiler seam, which has an efficiency of 96 per cent. The dome ring is welded at the top and has no outside welt. The very long seams are welded for a length of 11 ins. at each end. The tube spacing provides ⅞-in. bridges, the tubes being arranged in vertical rows. The Pacific type has 2¼-in. flues because of their length, 20 ft., while the others are of 2 ins. in diameter. All of the boilers are fitted with 8-in. dry pipes with the Rushton open top throttle. The side stays are ⅞ in. in



CROSS-SECTIONS THROUGH FIREBOX—PACIFIC TYPE.



CROSS-SECTIONS THROUGH FIREBOX—SWITCH ENGINES.



CROSS-SECTIONS THROUGH FIREBOX—CONSOLIDATION TYPE.

diameter with 3-16-in. holes drilled 1¼ ins. deep in the outside ends only.

All the 70-in. boilers have 13-16-in. shell plates, and all the fireboxes have the same sheets. These boilers are all fitted with the Bates fire door, which is standard on the Southern Pacific Railway. All of the back heads are flanged to an angle of 15 degs. from the vertical, including the switcher.

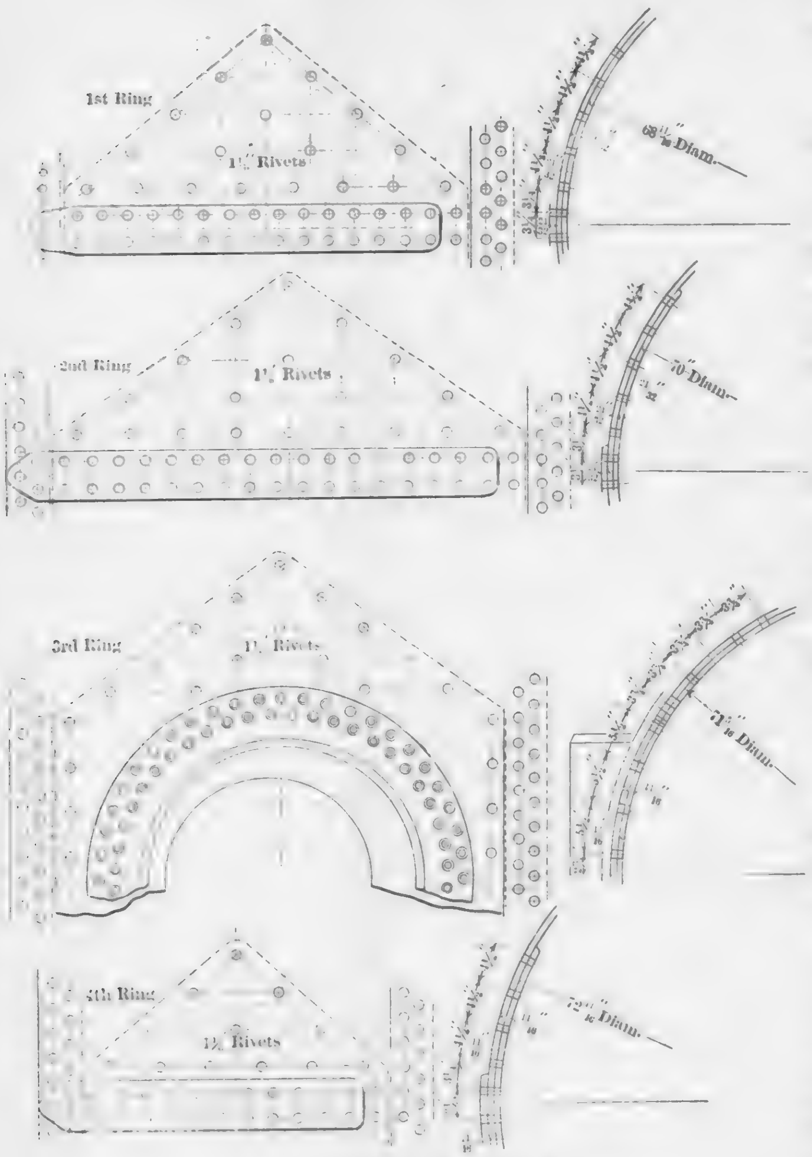
The switcher boiler is the only one with a narrow firebox. Its length is 108 ins. and its width 40¼ ins. This boiler has the same method of crown support, the same fire door and bridging of tubes as the other boilers. Except the switcher, which carries 180 lbs. steam pressure, all the boilers are built for 200 lbs. with a seam factor of five.

This set of standard boilers has been designed with unusual care in order to reduce to a minimum the amount of work in the boiler shop.

For information, drawings and permission to publish this description we are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines and to the Baldwin Locomotive Works. To the Baldwin Locomotive Works we are also indebted for the following description of the Vauclain diamond boiler seam which has been used by them for several years:

DIAMOND BOILER SEAM.—The accompanying engraving illustrates this seam as applied to the first, second, third and fourth rings, these joints having been designed for a working pressure of 220 lbs.

A well designed multiple riveted boiler joint would usually fail by tearing the plate along the outside row of rivets. It is, therefore, evident that the most efficient joint is the one that has a minimum amount of metal removed from this section, and at the same time has a sufficient number of rivets in the welt to prevent their shearing. This is the principle of the diamond seam, and because of its high efficiency it allows a considerable decrease in weight without greatly increasing the cost.



DIAMOND BOILER SEAM.

The calculations for the efficiency of this joint are the same as for any other multiple joint; like them it can fail by shearing the rivets, tearing the plates, crushing the rivets or plate or riveted joints; the bearing pressure per square inch is so small that the last method need not be considered.

To determine the efficiency it is necessary to calculate the strength of each line of riveting separately and compare it with the strength of the solid plate.

Considering the joint for the first ring we have:

46 ins. wide (rivet to rivet).
21-32 in. thickness of plate and welts.
1⅛ ins. diameter of rivets.
55,000 lbs., tensile strength of steel.
36,093 lbs., tensile strength of strip of plate 1 in. wide.

Through the first line of riveting the plate is weakened by the cross section of one rivet hole.

Therefore the net strength of this section is:

(46 ins. — 1⅛ ins.) x 36,093 = 1,623,272 lbs.

Strength of solid plate:

(46 ins. x 36,093) = 1,660,278 lbs.

Efficiency, = 1,623,272 / 1,660,278 lbs. = 97.7%

The second line of riveting is weakened by the removal of metal for two rivets, but in order to fail here the rivet in the first line must shear.

Therefore net strength of this section is:

Strength of plate = (46 ins. — 2¼ ins.) x 36,093 = 1,579,068
Single sheet 1 rivet .994 x 40,000 = 39,760

Total, 1,618,828

Efficiency, 1,618,828 / 1,660,278 = 97.4%

Third line of rivets:

3 holes 1⅛ ins. dia. = 3¾ ins. net area of metal removed. Reinforced by 3 rivets in 1st and 2d row in single shear. Strength of plate = (46 ins. — 3¾ ins.) x 36,093 = 1,538,463
3 rivets 1⅛ ins. dia. single shear = 3 x .994 x 40,000 = 119,280

Total 1,657,743

Efficiency, 1,657,743 / 1,660,278 = 99.8%

Fourth line of rivets:

4 holes, 1⅛ ins. dia. = 4½ ins. net area of metal removed. Strength of net area of plate = (46 — 4½) x 36,093 = 1,497,860
6 rivets 1⅛ ins. dia. in single shear 6 x .994 x 40,000 = 238,560

Total 1,726,420

Efficiency slight excess over solid plate.

Fifth line of rivets:

8 holes 1⅛ ins. dia. = 9 ins. net area of metal removed. Strength of net area of plate = (46 — 9) x 36,093 = 1,263,255
10 rivets 1⅛ ins. dia. in single shear = 10 x .994 x 40,000 = 397,600

Total 1,660,855

Efficiency—slight excess over solid plate.

Sixth line of rivets:

The seam fails at this point by shearing the rivets between the outside welt and plate and by tearing the inside welt between the rivet holes.

15 holes 1⅛ ins. dia. = 16⅞ ins. net area of metal removed. Strength of net area of plate = (46 — 16⅞) x 36,093 = 1,051,208
14½ rivets, 1⅛ ins. dia. in single shear = 576,600

Total 1,627,808

Efficiency, 1,627,808 / 1,660,278 = 98%

Therefore, this particular design of seam has a minimum efficiency of 97.4%.

Enormous Traffic in Cities.—In New York, with its population of 3,750,000, there are being carried now on the surface, elevated and subway systems paying passengers, exclusive of so-called transfers, 1,200,000,000 per annum, a number very much greater than the number of passengers on all the steam railroads of both the American continents from the Atlantic to the Pacific, and from that most northern of all railroads, the Wild Goose Railway, near Nome, Alaska, within the Arctic Circle, to the most southern one in South America, the State Trunk Line, of Chili. London, with its population of over 6,000,000, but with inferior intra-urban railway facilities, carries about the same number as New York; while Paris, Berlin, Hamburg, Boston, Chicago and St. Louis are fast following in the leaders' tracks. Such figures need no further comment or explanation to indicate the dimensions of the problems of transit in great cities, and the difficulty of properly meeting the continual demand for increase in facilities as cities grow.—*W. B. Parsons, before Purdue students.*

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

Editorial Correspondence.

Naples.

After a visit to England, France, Germany and Switzerland, and making as careful a study of railroad conditions as time permitted, we find ourselves in Naples, ready for the return voyage, after a most delightful tour. As no one in Italy appears to work, the time spent here was devoted entirely to enjoyment of the wonderful attractions with which this most interesting country abounds.

I cannot avoid a few general observations, the first of which is to point out the value of knowing by personal contact the conditions under which transportation has been conducted for many years abroad. One may visit Europe with a preconceived opinion that nothing is to be learned which will be of any value for application at home. However, by looking under the surface of English and Continental railroad practice a great deal is to be learned, and the impression soon grows into a conviction that American methods can be materially improved by engrafting some principles from Europe.

Of these principles, the one which I most earnestly desire to see adopted at home is the attitude of all, not only the railway officials, but the public, towards the locomotive and the men who are responsible for it, and for its use. Until we learn at home that the locomotive earns every dollar brought into the treasury, and until we learn that the men responsible for the locomotive and its work are really entitled to the high standing given to motive power officials abroad, and until we make the life of a motive power officer worth living, we have more to learn from England and the Continent than England and the Continent have to learn from us. If American railroad presidents should go where I went and meet the men I met they would return prepared to perform the best service for their stockholders that they have ever performed. This would not be by copying anything they saw abroad, but by acquiring appreciation of the possibilities to be had from putting the American locomotive and American motive power men upon their rightful and needful basis. This will be done some day, not for sentimental, but for purely business reasons.

Little remains unsaid as to the value of a tour out of one's own country. The mere getting on board of a magnificent steamer, the observation of the working of the ship, watching the continuous operation of the machinery for ten days without an "engine failure," the very certainty of navigation and its mathematical accuracy convey impressions of the worthiness of men. We purposely chose a slow steamer. On approaching the English coast at four o'clock in the afternoon the first officer promised that we should see the Scilly Island light on the port bow at 7:30 o'clock that evening. After nine days of by no means good weather the light appeared at 7:45, and it was on the port bow. This tells a story of years of development of ships, of machinery and of men.

It does no harm for one living in a new country to see that which is really old, and here in Italy we see it. It gives at first a strange impression to gaze on the bronze doors of the Baptistry in Florence, knowing that these doors were hanging there just as they are now when Columbus made his voyage. The conscientious thoroughness of the past centuries is also worth a thought. A snapshot picture of the Roman Forum, taken from an electric street car brings a reflection as to how our work will look when uncovered perhaps a couple of thousand years hence. This thought is most impressive in Pompeii, where all life was suddenly arrested in the midst of its activity, and is now revealed in all its detail.

I wonder if Raphael could possibly have dreamed that the Sistine Madonna, painted for an altar-piece for an obscure chapel, would become an object of pilgrimage. I wonder if he ever dreamed that that work of his hands and heart would cause a hush in a room in Dresden, and that people from an undiscovered country would derive an inspiration from it, which would perhaps affect in some degree their whole lives. Raphael died at the age of thirty-two. What inspired him and what enabled him to work so well?

A snapshot of the Cloaca Maxima where it empties into the Tiber shows an arch of stone, which for over 2,000 years has performed the duty of draining Rome, and performs that duty to-day. It tells a story of something thoroughly done for the benefit of future generations, which leaves an indelible impression upon one's mind. It is good to have seen these things, and their moral need not be pointed here.

I must now bring these letters to a close after the best and most inspiring trip that two people ever took. I can never express the grateful appreciation of the token so generously extended by the friends who made it possible.

G. M. Basford.

RAILROAD EQUIPMENT IN THE UNITED STATES.

On June 30, 1904, according to the Interstate Commerce Commission, there were in the service of the railways 46,743 locomotives, the increase being 2,872. As classified, these locomotives were: Passenger, 11,252; freight, 27,029; switching, 7,610. There were also 852 not assigned to any class.

The total number of cars of all classes was 1,798,561, this total having increased 45,172 during the year. The assignment of this rolling stock was, to the passenger service, 39,752 cars; to the freight service, 1,692,194 cars; the remaining 66,615 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 220, showing an increase of 6. The average number of cars per 1,000 miles of line was 8,474, showing a decrease of 66 as compared with the previous year. The number of passenger-miles per passenger locomotive was 1,948,384, showing a decrease of 30,402 miles. The number of ton-miles per freight locomotive was 6,456,846, showing a decrease of 351,096 miles as compared with June 30, 1903.

The aggregate number of locomotives and cars in the service of the railways was 1,845,304. Of this number 1,554,772 were fitted with train brakes, indicating an increase during the year of 92,513, and 1,823,030 were fitted with automatic couplers, indicating an increase of 52,472. Practically all locomotives and cars in passenger service had train brakes, and of the 11,252 locomotives in that service 11,113 were fitted with automatic couplers. Only 602 cars in passenger service were without automatic couplers. With respect to freight equipment, it appears that most of the freight locomotives had train brakes and automatic couplers. Of 1,692,194 cars in freight service on June 30, 1904, 1,434,386 had train brakes, and 1,674,427 automatic couplers. In this report there have been continued several summaries, first presented in the report for 1902, to show the general type and efficiency of locomotives and the capacity of freight cars.

In these summaries locomotives are classified under the heads of single-expansion locomotives, four-cylinder compound locomotives, and two-cylinder compound or cross-compound locomotives. Each of these classes of locomotives is further classified according to the number of drivers and the number of pilot wheels and trailers.

Advice to Draftsmen.—Exercise your "gray matter" a little before doing things rather than "the boss's" patience afterward.

A rule is sometimes best observed in the breaking rather than the keeping. Heed the spirit as well as the letter of all instructions.

The men who make the pieces are not draftsmen and should not be supposed to know more about a piece than is given on the drawing.

A drawing is plainer to the man who makes it than to the mechanic who first sees it when he is started on the work. Consider what you would want to know if you were to make the piece correctly under the workman's circumstances.

Strive for clearness, completeness, simplicity and neatness.—*Edwin W. Beardsley—Machinery.*

STEEL CAR EQUIPMENT.

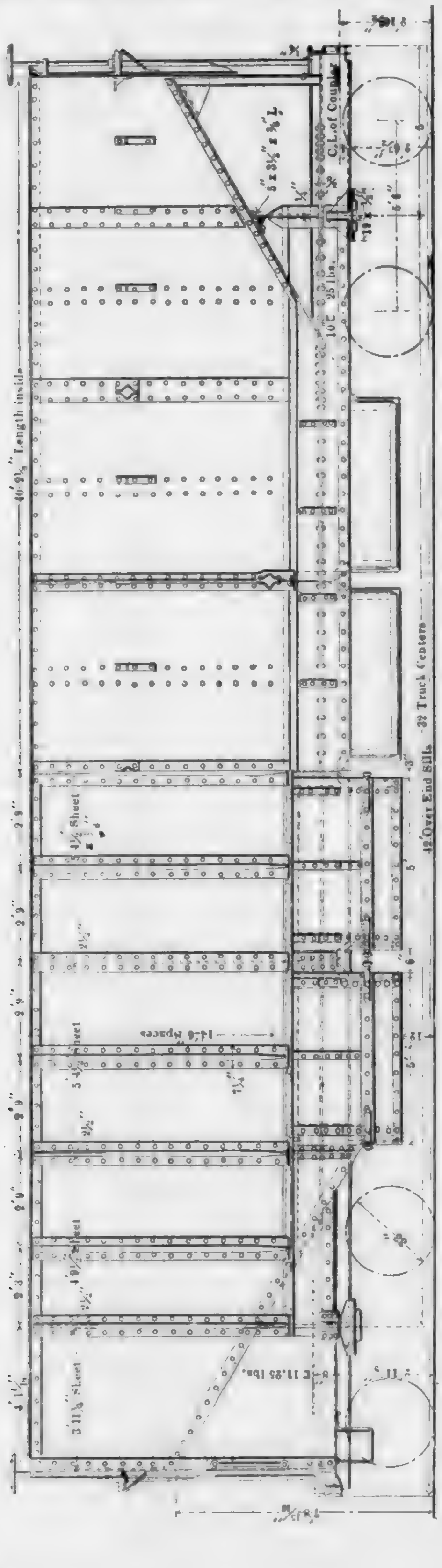
PENNSYLVANIA RAILROAD.

VII.

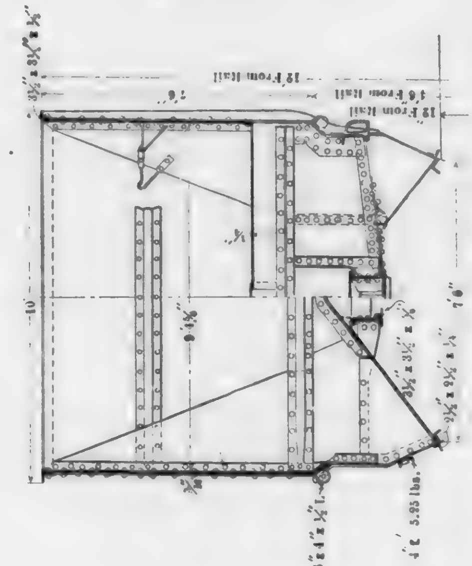
(*For Previous Article See Page* 148.)

The two classes of steel coke cars, designated as Classes GP and GPA employ structural steel frames and provide very large cubical capacity in an arrangement discharging the load through eight doors at the sides of the car. The two designs are similar in principle, the essential differences being in the 12-ft. sides of the GP class, which has no coke racks, and the 10-ft. sides of the GPA, which has coke racks.

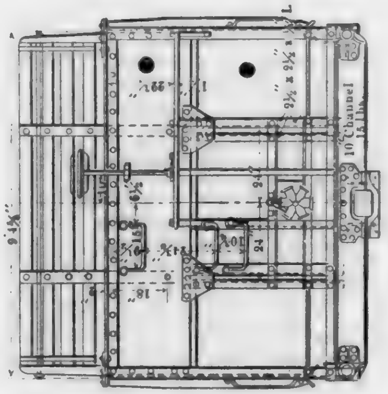
The table of dimensions indicates their very large cubical capacity, the leading dimensions and the weights. The back bones of these cars are of 10-in. 25-lb. channels for center sills, which are reinforced between the bolsters by 3½ x 3½ x ⅝ in. angles and by coverplates which extend on both sides of the bolsters from the hoppers to points near the ends of the car. These plates are ⅜ in. thick. There are no continuous side sills. Short side sills extend from the end sills to the hoppers. These are 8-in. 11.25-lb. channels, and they are built into the bolsters, which are very deep and are made in the form of single-plate diaphragms. In the sides of the car 6 x 4 x ½ in. angles act in a measure as side sills and form an angle for the hoppers as indicated in the sectional views. The side



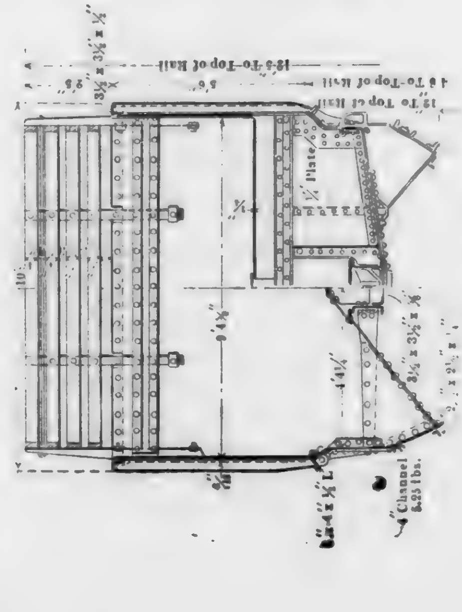
50-TON STEEL COKE CAR, CLASS GP, PENNSYLVANIA RAILROAD.



HALF SECTION THROUGH DROP DOORS AND NEAR BOLSTER.
CLASS GP COKE CARS



END VIEW



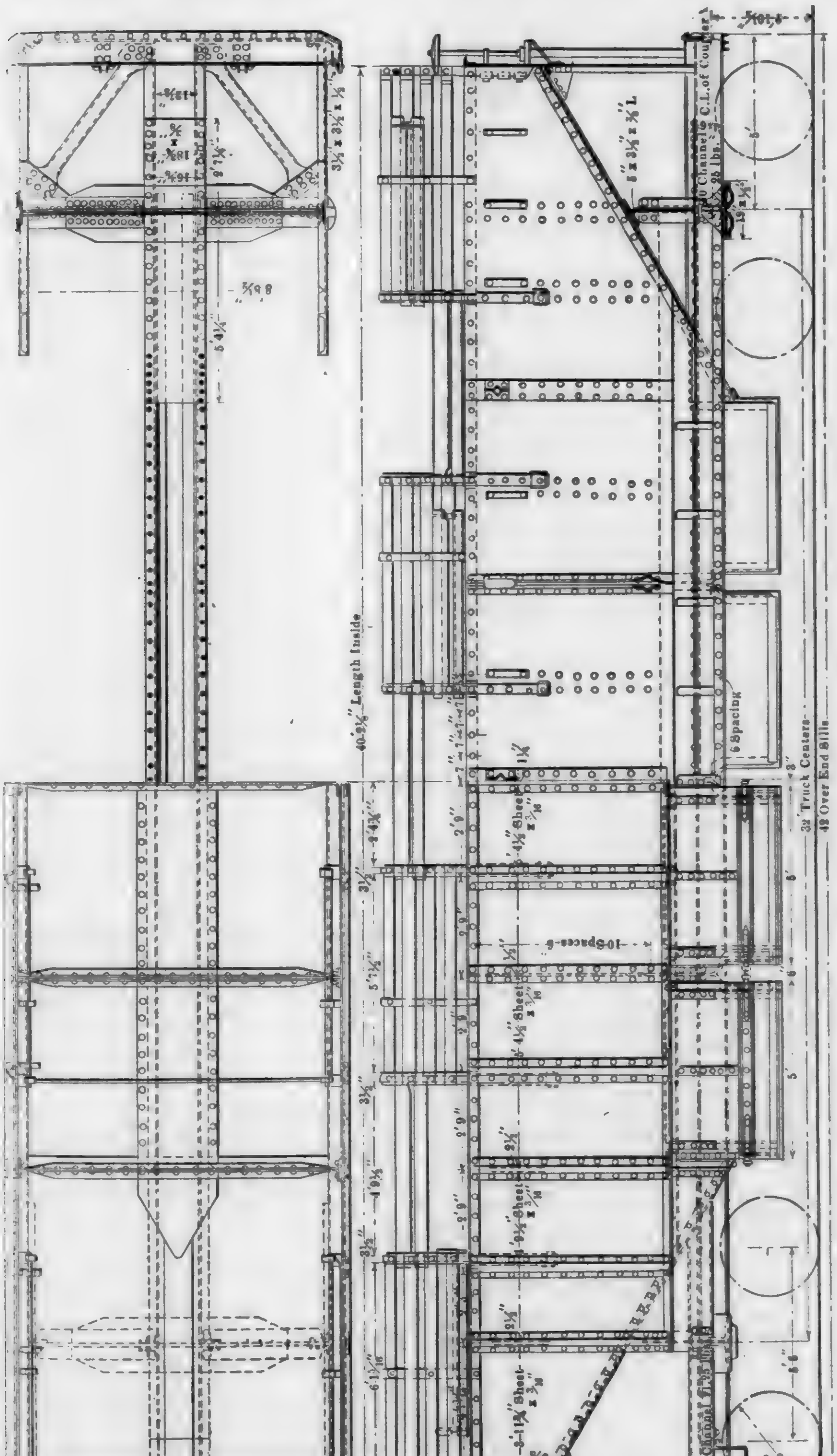
HALF SECTIONS THROUGH DOORS AND NEAR BOLSTER.
CLASS GPA COKE CARS.

…ating of these cars is of 3-16-in. material and the floor of … in. The body bolsters extend backward and support the …oping floor by an attachment between a pair of 5 x 3½ x … in. angles. The floor of the car is given the form of a …od from the center sills and discharges the load towards …e sides through 8 doors, which are 5 ft. long. The end sill …nstruction and the corner bracing are the same in both of …ese designs, the end sill being a 10-in. 15-lb. channel with a …-in. plate on top to which the end posts and the corner …racings are riveted.

The door operating mechanism is actuated from one end …f the car. An inclined capstan shaft operates joints leading …o two longitudinal rods extending under the hood of the …opper at the center of the car. These rods operate 5 horizontal chain wheels, each of which carries 2 crank pins to which the door rods are attached. When in a closed position these crank pins are on dead centers and lock the doors. When the capstan is turned in an opposite direction the doors are opened positively. Both classes of cars are equipped with Westinghouse friction draft gear.

COKE CARS, PENNSYLVANIA RAILROAD.

	Class G. P.	Class G. P. A.
Length inside	40 ft. 2⅛ ins.	40 ft. 2⅛ ins.
Length over end sills	42 ft. 0 ins.	42 ft. 0 ins.
Height of side from rail	12 ft.	12 ft. 5 ins.
Width outside	10 ft.	10 ft.
Width inside	9 ft. 4⅝ ins.	9 ft. 4⅝ ins.
Truck centers	32 ft.	32 ft.
Cubical capacity, level	3,123.5	3,187.3
Cubical capacity, heaped	3,406.5	3,441.1
Nominal capacity	50 tons	50 tons
Light weight	52,500 lbs.	50,000 lbs.



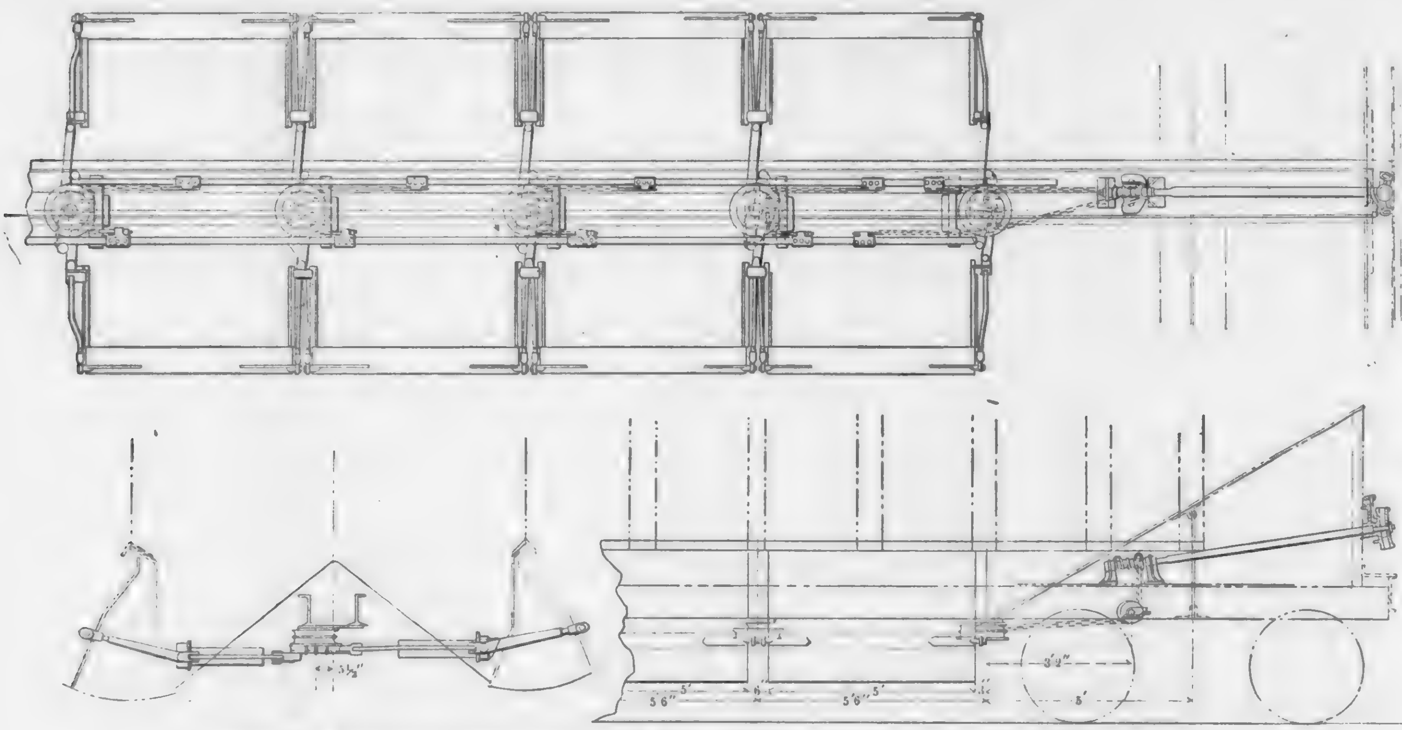
50-TON STEEL COKE CAR, CLASS GPA, PENNSYLVANIA RAILROAD.

INJECTOR STRAINERS AND SUCTION PIPES.

There can be little doubt but that the present suction pipe connection between the engine and the tender is a very inefficient makeshift. The life of the suction hose is short, and unless carefully attached is apt to buckle or collapse on short curves; the internal coil of exposed wire or a loose lining interferes with the free flow of water, and it is evident that this device could be easily improved. It is suggested that the foreign method of telescopic pipes is far better, if such arrangement could be made, with a simple form of joint and without leaks at the stuffing box. Similar devices are used on English roads and also upon some of the Continental systems.

It is generally acknowledged that the strainer is one of the chief sources of delay and trouble in the care and handling of injectors. Modern practice tends toward the use of a large pot strainer within or below the tender tank, with suitable means for quick removal and cleaning of the strainer plate. An objection to this system lies in the fact that neither the strainer nor the tank is frequently cleaned, and it is difficult to render such a device easily accessible; a simple and practical supplemental arrangement is to place a straining plate in a special body or casting at the lower end of the suction pipe and between it and the hose. A suitable opening with locking device is provided for the withdrawal of the straining plate, which should be made of heavy punched sheet copper full of small holes. Attempt has been made to clean strainers of this kind by admitting a jet of steam at the upper end, but this has not proven a commercial success, and has certain disadvantages. In all strainers, however, the diameter of the holes in the straining plate should be small, and the total area enormously exceed that of the suction pipe, to allow for the stoppage of a large number of the holes before the necessity is felt for removal and cleaning.—*Traveling Engineers' Association.*

Tests made at Melbourne have demonstrated the enormous strength of the Victorian eucalyptus. A piece of the wood 5 ins. thick withstood a strain of 27,650 lbs.



DROP DOOR OPERATING MECHANISM, CLASS GP AND GPA COKE CARS—PENNSYLVANIA RAILROAD.

THE ORGANIZATION OF RAILWAY SHOP FORCES.*

Much has been written lately on the subject of shop tools; the very interesting discussion brought out by Mr. Barnum's paper in March (AMERICAN ENGINEER, April, 1905, page 133) showing to what extent it was appreciated. In that paper the writer said if he had to choose between old shops and new tools, or old tools and a modern shop, he would prefer the former, in which conclusion I agreed with him; we can carry these suppositions still further and ask ourselves whether it is better to have new tools and shops with a poor organization of shop forces or to have a good organization and comparatively old tools and shops. I would prefer the latter, and undertake to do more work in a given time than in a modern shop with a full complement of new tools and a poor organization.

In getting together a force of men sufficient to man a shop capable of turning out, say twenty to fifty locomotives a month (it really doesn't matter how many engines the shop turns out, the building up of an efficient force is very necessary in all cases), the first consideration is to pick a man for the head, whether as general foreman, master mechanic or shop superintendent, who can be implicitly relied on to carry out the plans you formulate for him, and to have such ideas of his own that he will immediately see where delay or friction occurs and apply a remedy. As head of the shop he must have a firm disposition, be prepared to meet emergencies, have the good will of the foremen and men under him and be tactful so as to be able to straighten out the many little difficulties that are continually arising; it is far better if he has no relatives or friends working for him, as it will save lots of trouble from fancied discrimination, etc. He must be an organizer in the true sense of the word, and every move he makes must be in the direction of increasing his output and decreasing the cost. He should not allow work to be done carelessly or improperly; it takes a long time to build up a reputation for thoroughness, which can be shattered in a few weeks if work is slighted. I am not a believer in frills and unnecessary ornamentation, but do think that it is poor economy to half do a job when most of the expense is incurred in getting to it, and not actually doing it, besides which it engenders loose habits among the foreman and men.

When an engine comes into the shop for repairs, it should be the duty of one or more men to inspect it, and immediately order all of the new material required and, see that it is placed at the machines or benches ready to be worked on when its time comes—don't wait two or three days after the engine arrives, and then find you want something that isn't in stock but ought to be; it will probably mean a delay to the engine going out, which might have been prevented if an earlier inspection had been made. In dissembling engines, each part should be plainly marked, so that when wanted again there will be no difficulty in finding it; the storage of parts that need no repairs is a matter worthy of attention; much material is lost through neglect in storing it away where it cannot readily be found when wanted. To get engines or work out of a shop there should be a classification of repairs and each piece of work done, or each engine passing through the shops should have a schedule of time, so that all concerned know when it will be necessary for the various parts to be ready. Don't do things haphazard. Set a time limit and work to it, making such improvements in tools, ways and means of doing work, etc., so that all lost motion is taken up, and the results you are after obtained.

The head of the shop should have good men under him as foremen, all of them knowing their business thoroughly, and at the same time being able to handle men with consideration, firmness and fair dealing; these combinations are frequently hard to get, but, with a large force of men to pick from, the right kind of men can be found who, by a little training, will meet the above requirements and soon get into his way of doing business. A good plan to adopt with your foremen is to hold weekly meetings for say an hour and review the work that has been done and that which is ahead of them. Let them tell you how conditions can be improved, what is delaying their work, etc. This getting together is very helpful to the superintendent of shops, as he quickly gets in touch with details, and at such times he can say what results he is after and offer encouragement to get them. The shop superintendent who is wise will lend an ear to suggestions made by his foreman or men when they can show a way by which better results can be obtained; once make light or ridicule a suggestion from any one, however humble in position, and another will not be offered. The mechanic who tells you that a certain casting has more metal on it than is necessary is helping you to get results, and the least you can do is to listen and try to remedy the trouble by asking to have the pattern changed.

The organization of shop forces does not end with the getting

*A paper by Mr. H. T. Bentley, asst. S. M. P., C. & N. W. Ry., read before the Western Railway Club.

together of good foremen and men; it is also necessary to have such a systematic arrangement of accounts and reports that you will not only see that the men are getting the work out promptly, but can tell at a glance how much is being done and what it is costing; without this knowledge you are not able to perfect the organization to its fullest extent; it also enables you to say, when asking for new tools, what can be saved in time and money by their introduction, and to know whether it will be cheaper and better to purchase supplies, taps, reamers, etc., or make them in the shops.

The superintendent of motive power who visits his shop frequently and knows all his foremen, can get better results and have the men feel more kindly disposed towards him than the one who does all his visiting by long distance telephone; a word of encouragement and a suggestion will often bring out latent ideas that otherwise might have lain dormant. It is natural for most men to like their superiors in position to come in personal contact with them and see what they are doing, and whether advantageously or not, hence, the advisability of the superintendent of motive power or his assistant making frequent visits to the most important shops and keeping in close touch with the shop superintendents and foremen.

A shop organization is not complete without some means of handling a fire, should one occur. A volunteer fire company, formed of the men who have been in the service some time and are likely to stay there, should be formed and a man put at the head who can handle them properly; they should practice at least once in two weeks, familiarizing themselves with fire hydrants, hose, etc. A little encouragement from the officials in charge will keep up enthusiasm, and at a critical time your volunteer company may be in a position to save you thousands of dollars and keep the shops from burning down and throwing themselves and co-workers out of employment. A watchman system, which will necessitate the patrolling of the shops at stated intervals, will often be the means of catching an incipient fire and enable it to be put out before getting beyond control. The checking-up of watchmen, to know that they are making their rounds at stated intervals, is necessary; it isn't enough to know they are on the payroll, you must know, through the medium of some check clock system (there are many good ones on the market), that they have faithfully discharged their duties.

The organization of forces includes, among other things, the prompt movement of work and tools to the men. What does it profit a superintendent of shops if he has a first-class machine and an up-to-date man handling it if he has to tie it up several times a day while he goes to get a tool dressed or sharpened, or the supply of material is not on hand when wanted. A sufficient number of tools, properly sharpened and dressed, should be available at all times, within easy reach of the mechanic, or, better still, have a boy who can keep the men supplied. A shop telephone system will aid in getting out work and will enable the foremen to quickly obtain information from each other, or from the shop superintendent and vice versa, and save endless running about, which is a waste of time and energy.

The placing of machine tools so that the minimum amount of handling material takes place, will increase the output and save a great deal of disorder and unnecessary work in moving it back and forth; where possible, a piece of work should travel from brass foundry, storehouse or blacksmith shop to the various machines so that it never makes a retrograde movement, and when completed should go direct to its resting place, which should not be around the man or machine finishing it. Always have plenty of unfinished work before your men, and remove that which is completed as soon as possible.

Labor-saving devices are a good thing, but they, like other good things, can be carried to extremes. Put an air or electric hoist where it will save delay in handling work, but don't put anything up that will cause a man to wait until some one else has finished with it, when without it he would have handled the work himself in a quarter of the time if no power hoist had been available. Pneumatic tools, hammers, drills, etc., are indispensable in doing work quickly and should be used wherever possible, but 50-ton hoists handling 50-pound loads is a waste of power, and should not be allowed. Keep your pneumatic tools in first-class shape and stop all air leaks—it saves the compressor.

The mechanical engineer, while not directly coming under the head of organization of shop forces, is, however, a potent factor in getting results. A bad feeling exists among foremen when castings or forgings come to their machines improperly designed or with more metal on than is necessary. The frequent breakage of parts that could be readily corrected is something that the mechanical engineer's office is often responsible for, and a man in this position who quickly corrects complaints that are made to him enables the shop organization to be perfected in a way that few people realize.

The boilermaker foreman finds out that an engine is coming into the shops for a new firebox: his organization would be very weak if he waited until the engine was actually in the shop before some action had been taken looking towards the building of a new firebox, so that as soon as the old one had been removed the new one would be ready for application; the same with engines requiring new side or flue sheets, the material should be on hand before it is needed, or much precious time is lost and the whole machine is temporarily disorganized.

The blacksmith shop generally is not a place that looks neat and tidy; there are, however, some notable exceptions to the rule, and orderliness pays there just as much as anywhere else. The turning out of duplicate work by machine instead of by hand makes a big reduction in cost, and the blacksmith foreman who can organize his work and men so that he is always in the van instead of the rear is a valuable addition to the shop organization.

The tank shop, tin shop, paint shop, brass and iron foundries, etc., deserve a word. It is not necessary for me to go into details about these shops, but they all play their parts in getting results; it is of no avail if the machine and erecting shops have the engines finished on time if they have to lay around two or three days waiting for the tender. All must work harmoniously or the results obtained will be unsatisfactory. The power plant is an important factor in the smooth running of a shop. Engines that are continually falling down or are too small to carry the load, and boilers that do not furnish enough steam, especially when the weather gets cold, are a trial and tribulation to the man who is trying to get there. Relay engines and boilers cost money, but often save shutting up shop when it can least be spared.

Apprentices should be given opportunities to learn their business thoroughly, as we depend upon them to make our future mechanics; if they are looked upon and treated as necessary evils we may expect indifference and indolence from them; but if treated properly and shown how to do their work efficiently and quickly they will, in most cases, turn out desirable men to keep in the shops. In our home life we endeavor to educate our children so they will grow up and be a credit to us and to themselves; then why, in our business life, should we not do the same with the young men who come to us for mechanical training? Special apprentices, who have graduated from a technical college, are invaluable if made of the right kind of stuff. In a large establishment conditions are often arising where some special information has to be obtained, which necessitates mechanical training, and a certain amount of technical knowledge to properly work up the data. In this field special apprentices can be used to advantage, and later, when they have completed their term of apprenticeship, if competent, they can be used in higher positions to advantage.

This is the age of specialists, and in hiring men you will find some who are first-rate mechanics in one line and not much good in another. The good all-around mechanic, like the old family physician, is disappearing from our midst, and instead, we get the air brake man, machine hand, the valve setter, the man who is handy at lining up guides, etc. Find

out what your man's strong forte is and use him at it, wherever possible; in a large shop this can be done to advantage with a corresponding increase in your output.

Always be on the outlook for promising timber in the shape of young, energetic and progressive men, and encourage them, so that when in want of a foreman or master mechanic you will know where to find one. Many a good man has been lost to the profession through lack of encouragement. Nothing stimulates a man so much as to know that his work is appreciated. Have we not all felt animated and enthused to do better when we have received a word of approval and praise? Some of us are prone to find fault, and we do that unsparingly, but how often do we give credit where it is due? Most of us, I am afraid, take it as a matter of course, and let it go at that; try the other plan occasionally, and see what results you will get. Don't have too many rules, bulletins and notices; they take up the men's time reading and discussing them. Only make such rules that you know can and should be carried out, and then see that they are lived up to.

The motive power department organization can be demoralized and nearly put out of business if it is not backed up by the storekeeping and accounting departments. The prompt furnishing of material in sufficient quantities to keep machines going long enough to perform the work economically is a matter that must have attention, otherwise the cost will immediately go up. The setting up of some machines often takes longer than to do the work, if furnished in small amounts, and a direct loss to the company takes place. The furnishing of cost sheets within reasonable time after the work is done is very helpful in detecting increased or decreased cost, and applying the remedy in the former case before the matter gets old. In some shops messengers are used to deliver material, and they are great time savers when used in connection with a shop telephone system. The ordering of material is done by 'phone to storehouse, and deliveries are made from there by boys or men, thus obviating the necessity of high-priced mechanics going back and forth doing work that is just as well performed by cheaper labor. Nothing looks so bad in a shop as material, whether usable or scrap, being allowed to lay around indiscriminately—a man is frequently what his surroundings are; if neat and clean, he unconsciously, perhaps, becomes so; but where dirty and untidy, he would make it more so by throwing things down that he otherwise would be ashamed to do, if a proper example had been set him in orderliness. Some people think it doesn't pay, but try both methods and you will quickly find that a dirty shop is the most expensive to handle, and most unsatisfactory for all concerned. Have distinctive marks on scrap and usable material, and see that it goes where it belongs when once picked up—it is cheaper than to set it down and pick it up later on.

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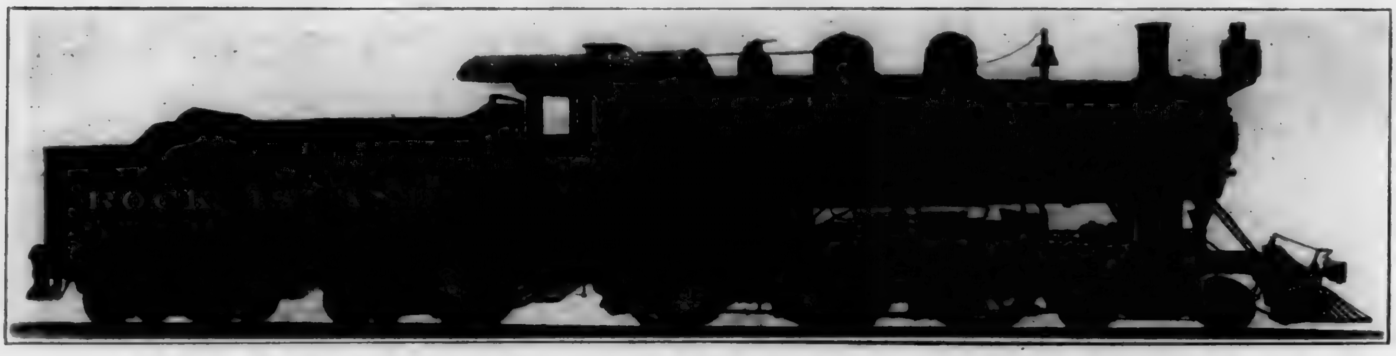
FREIGHT LOCOMOTIVE 4—6—0 TYPE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

In the table of standard locomotives recommended by the Rock Island Power Committee, which appeared in this journal in March, page 84, two 4—6—0 designs were presented, the chief differences being in the size of the driving wheels. The purpose of the two sizes of the driving wheels in the 4—6—0 type is to provide locomotives which may be used in either passenger or fast freight service without using too heavy weights to be satisfactory over the entire system. The accompanying photograph illustrates one of thirty-eight locomotives built by the Baldwin Locomotive Works to which Walschaert valve gear has been applied. The extent of the use of the Walschaert gear in this case indicates the confidence which these builders have in it for the purpose of meeting present conditions of locomotive service. This design has balanced slide valves. It has a tractive power of 34,000 lbs., and the accompanying table presents the leading dimensions and ratios. In the August number of this journal, page 282, the Pacific type was described, and in the September number, page 329, the Atlantic type. Next month the six-wheel switcher will be presented.



FREIGHT LOCOMOTIVE, 4-6-0 (TEN-WHEEL) TYPE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

4-6-0 TYPE FREIGHT LOCOMOTIVE, CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

RATIOS.	
Tractive weight ÷ tractive effort	3.86
Tractive effort x diam. drivers ÷ heating surface	828
Heating surface ÷ grate area	57.6
Total weight ÷ tractive effort	5.11
Gauge	4 ft. 8½ ins.
Cylinder	22 ins. x 26 ins.
Valve	Balanced, Walschaert Gear.
BOILER.	
Type	Wagon top.
Material	Steel.
Diameter	68 ins.
Thickness of sheets	11-16 in. and ¾ in.
Working Pressure	200 lbs.
Fuel	Soft coal.
Staying	Radial.
FIREBOX.	
Material	Steel.
Length	96¼ ins.
Width	67¼ ins.
Depth front	72¼ ins.
Depth back	58 ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	9-16 in.
WATER SPACE.	
Front	4½ ins.
Sides	4½ ins.
Back	4½ ins.
TUBES.	
Material	Iron.
Wire gauge	No. 11.
Number	329
Diameter	2 ins.
Length	14 ft. 2 ins.
HEATING SURFACE.	
Firebox	160.8 sq. ft.
Tubes	2,426 sq. ft.
Total	2,586.8 sq. ft.
Grate area	44.9 sq. ft.
DRIVING WHEELS.	
Diameter, outside	63 ins.
Diameter, inside	56 ins.

Journals, main	10 x 12 ins.
Journals, others	9 x 12 ins.
ENGINE TRUCK WHEELS.	
Front, diameter	30½ ins.
Journals	6 x 12 ins.
WHEEL BASE.	
Driving	15 ft.
Rigid	15 ft.
Total engine	26 ft. 6 ins.
Total engine and tender	56 ft. 5½ ins.
WEIGHT.	
On driving wheels	131,200 lbs.
On truck, front	42,520 lbs.
Total engine	173,720 lbs.
Total engine and tender estimated	304,000 lbs.
TENDER.	
Wheels, No.	8
Wheels, diameter	33½ ins.
Journals	5½ x 10 ins.
Tank capacity	7,000 gals. water.
Tank capacity	12 tons coal.
Service	Freight.

BLACKSMITH SHOP.

CANADIAN PACIFIC RAILWAY.

ANGUS SHOPS, MONTREAL.

This part of the plant of the Angus shops serves both the locomotive and car department, and for this reason is arranged in the shape of the letter L, and is placed under two separate foremen. The building is 434 by 300 feet; one of the wings is 146 feet and the other 130 feet wide. The location of the blacksmith's shop was shown in the general layout plan illustrated in December, 1904, page 451. The wing ex-

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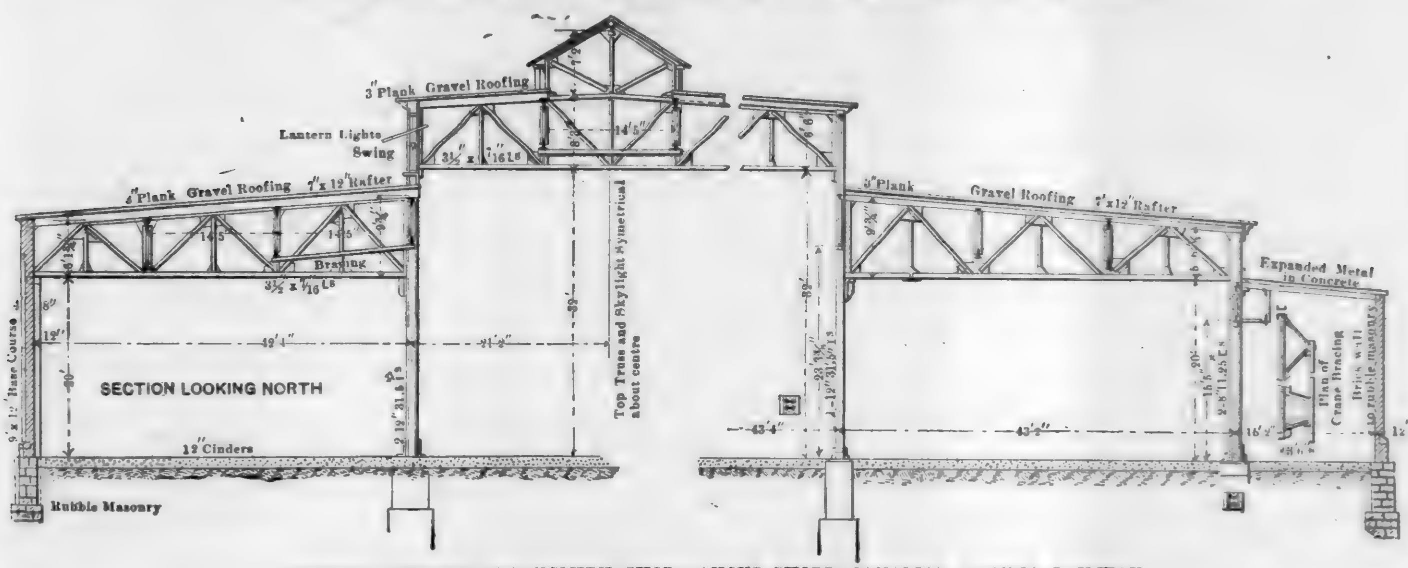

SECTION THROUGH BLACKSMITH SHOP—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

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The cross section and interior photograph, which was taken during construction, show the character of the building, the large amount of glass and the interior arrangement. The roof columns divide the building into three bays of equal width, and for the accommodation of the large furnaces a 15-ft. concrete addition is built along the locomotive wing. The building covers an area of 84,200 sq. ft., and provides a large amount of space for the forging department. Oil is used in all the furnaces, the supply being piped from underground reservoirs back of the grey iron foundry. The longer wing has one central track from end to end, the shorter wing has two trans-

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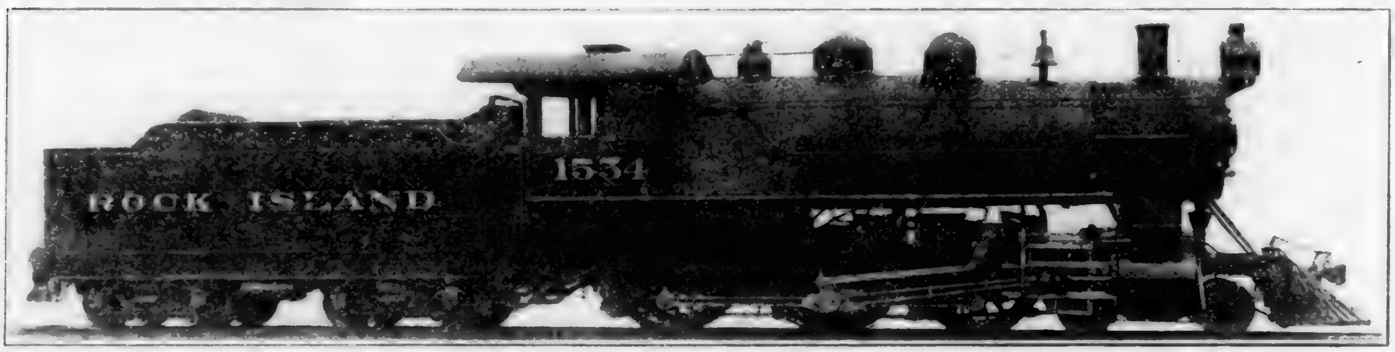

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4-6-0 TYPE FREIGHT LOCOMOTIVE, CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

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Tractive weight ÷ tractive effort	3.86
Tractive effort x diam. drivers ÷ heating surface	828
Heating surface ÷ grate area	57.6
Total weight ÷ tractive effort	5.11
Gauge	4 ft. 8½ ins.
Cylinder	22 ins. x 26 ins.
Valve	Balanced, Walschaert Gear
BOILER.	
Type	Wagon top.
Material	Steel.
Diameter	68 ins.
Thickness of sheets	11-16 in. and ¾ in.
Working Pressure	200 lbs.
Fuel	Soft coal.
Staying	Radial.
FIREBOX.	
Material	Steel
Length	96¼ ins.
Width	67¼ ins.
Depth front	72¼ ins.
Depth back	58 ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	9-16 in.
WATER SPACE.	
Front	4½ ins.
Sides	4½ ins.
Back	4½ ins.
TUBES.	
Material	Iron.
Wire gauge	No. 11.
Number	329
Diameter	2 ins.
Length	14 ft. 2 ins.
HEATING SURFACE.	
Firebox	160.8 sq. ft.
Tubes	2,426 sq. ft.
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DRIVING WHEELS.	
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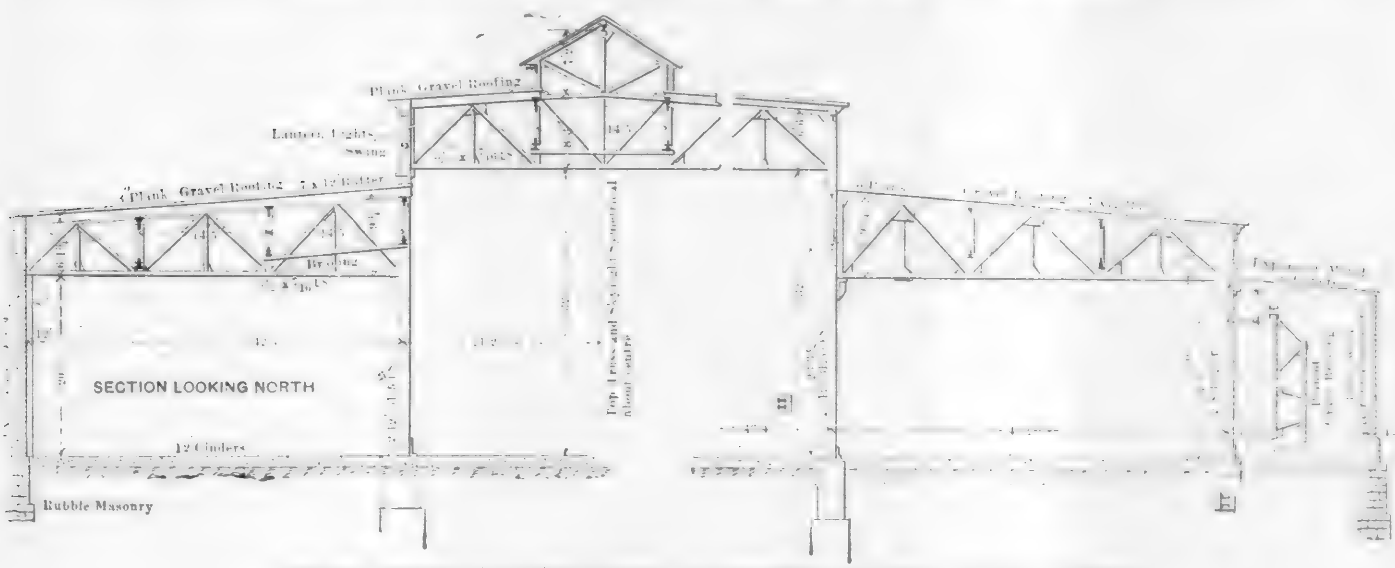

SECTION THROUGH BLACKSMITH SHOP—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

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verse tracks and the long side of the shop has six tracks leading to the midway crane, all being standard gauge.

This is an exceedingly busy department—in fact, it resembles a contract shop. The portion of the building for car work is essentially a manufacturing department, bolts and small forgings being transferred to the truck shop and other car department buildings in cast iron boxes. The writer saw some of these in the truck shop which were scarcely cool enough to handle. A great deal of work is done on store orders, indicating that a large amount of work is done for other points on the road. In the entire shop 61 fires were in use during the writer's visit.

This plant constitutes an interesting example of the use of oil furnaces, which are found to very greatly accelerate and cheapen the work. For example, parts for case hardening go into the case hardening furnace at 7 a. m. and are out at 11 a. m., thus in four hours work is done which formerly required ten hours. The oil furnaces save room, no coal is required, the shop is not cluttered by either coal or ashes, the furnaces are quickly fired up, and the heats are both quicker and more definitely controllable. The writer was told that in the locomotive wing scrap is piled, hammered into slabs and the forging finished for locomotive rods at a labor cost of one cent per lb. The cost is even less in the case of frames. The frame fires are at the south end, near the locomotive erecting shop, and the very heavy work is concentrated as near the locomotive shop as possible. At this end of the building are two large furnaces for frames and general heavy work and one for rods and other similar work. The Ajax 5-in. forging machine forms a part of the locomotive department equipment. It has an individual motor, and is used for a large variety of heavy work. At the angle of the building is the spring department.

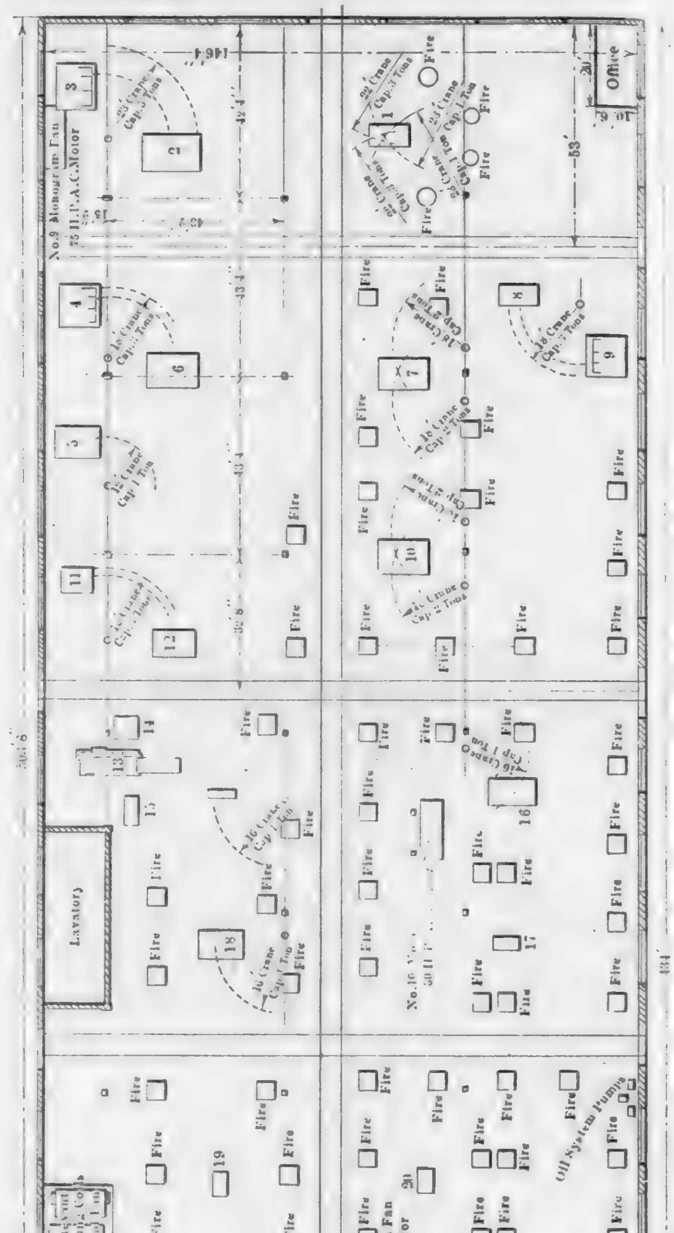
The floor plan shows the location of the machinery, the furnaces, lavatories, hammers and cranes. There are about thirty pillar cranes in this building, the capacities being given on the plan. The building is heated by the Sturtevant system with overhead conduits. The power throughout is electric, and the capacities of the motors are given in the list of equipment, which also gives the names of the firms furnishing the machines. The forge shop was planned with a view of using forging machinery as far as possible. This very important factor of the plant has received exceedingly careful attention, with a view of producing rapid work at low labor cost. The accompanying list includes all of the machinery and furnaces.

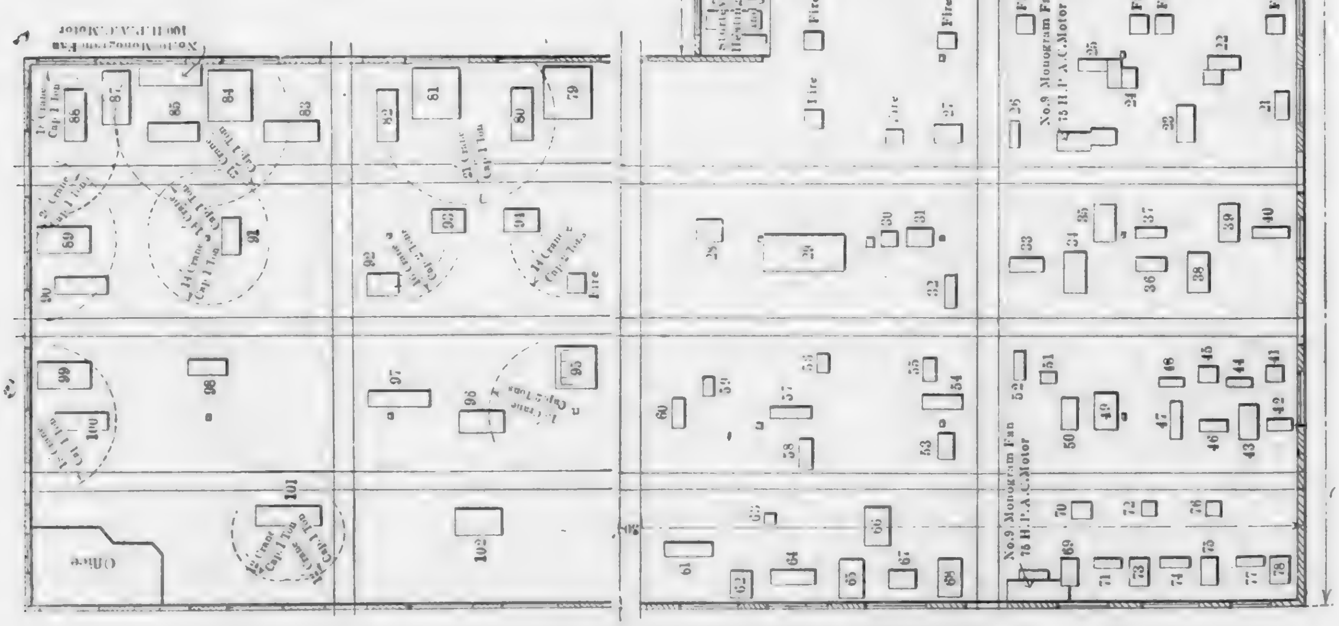
BLACKSMITH SHOP FURNACES.

3 Extra large forging furnace, 6 ft. 6 ins. deep x 18 ft. long, wit two doors, for 6,000-lb. hammer No. 2.

4 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors, fo 3,500-lb. hammer No. 6.

5 Case-hardening furnace, 5 ft. x 7 ft., standard design, clear ope ing in front.





PLAN OF BLACKSMITH SHOPS—ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

9 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors, for 3,000-lb. hammer No. 8.
11 Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 1,500-lb. hammer No. 12.
15 Small forging furnace for upsetting machine.
21 No. 2 forging furnace for Beaudry hammer No. 22.
25 No. 2 forging furnace for Beaudry hammer No. 24.
26 Small forging furnace for brake key rolls.
28 Spring bending furnace, 28 ins. wide x 31 ins. deep, with one door, for buckle press.
29 Spring tempering furnace to be 15 ft. 6 ins. long and 5 ft. wide, to be furnished with eight doors, arranged four on each side, for four fitters and four helpers.
32 Spring tempering and nibbing furnace, for spring rolls No. 30.
33 No. 2 forging furnace for Bradley hammer No. 35.
36 No. 2 forging furnace for Bradley hammer No. 38.
37 No. 2 forging furnace for Bradley hammer No. 39.
40 No. 2 forging furnace for Bradley hammer.
42 Small forging furnace, bricked up, for bolt header No. 43.
44 Small forging furnace, bricked up, for eye-bolt machine No. 41.
46 Small forging furnace, bricked up, for bolt header.
48 Small forging furnace, bricked up, for eye-bolt machine No. 45.
49 Forging machine, 5 ft. deep x 28 ins. wide, with one door for continuous rivet-making machine No. 50.
52 Small forging furnace, bricked up, for forging machine No. 51.
55 No. 2 forging furnace for 2-in. upsetting machine No. 54.
58 No. 2 forging furnace for 3-in. upsetting machine No. 57.
62 Forging furnace, 31 ins. deep x 28 ins. wide, with one door, for nut machine.
65 Forging furnace, 5 ft. deep, 28 ins. wide, with one door, for nut machine No. 64.
68 Forging furnace, 5 ft. deep, 28 ins. wide, with one door, for nut machine No. 67.
71 Small forging furnace, bricked up, for bolt header No. 73.
74 Small forging furnace, bricked up, for bolt header No. 39.
77 Small forging furnace, bricked up, for bolt header No. 78.
79 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 15 h.-p. bulldozer No. 80.
81 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 20 h.-p. bulldozer No. 82.
84 Double bulldozer furnace, to have two furnaces for heating material, each to be 8 ft. 11 ins. long x 36 ins. wide, and to have one door for 15 h.-p. bulldozers Nos. 83 and 85.
87 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 15 h.-p. bulldozer No. 88.
89 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h.-p. bulldozer No. 90.
92 Large forging furnace, 4 ft. 2 ins. deep x 36 ins. long, with one door for 2,000-lb. hammer No. 93.
95 Large forging furnace, 5 ft. deep x 7 ft. long, with two doors for 2,000-lb. hammer No. 96.
99 Single bulldozer furnace, 8 ft. 11 ins. long x 36 ins. wide, with one door for 10 h.-p. bulldozer No. 100.

LIST OF TOOLS IN THE BLACKSMITH SHOP.

Machine No.	*Description.*	*Maker.*	**Motor H.-P.*
1	2,000-lb. Hammer, old,	Bement-Miles & Co.,	
2	6,000-lb. Hammer, new,	Bement-Miles & Co.,	
6	3,500-lb. Hammer, old,	Davy Bros., Sheffield,	
7	1,200-lb. Hammer, old,	Davy Bros., Sheffield,	
8	3,000-lb. Hammer, old,	Bement-Miles & Co.,	
10	1,200-lb. Hammer, old,	Davy Bros., Sheffield,	
12	1,500-lb. Hammer, old,	Bement-Miles & Co.,	
13	5-in. Upsetting Machine, new,	Ajax Mfg. Co.,	15
16	600-lb. Hammer, old,	Davy Bros., Sheffield,	
17	400-lb. Hammer, old,	J. Bertram & Co.,	
18	600-lb. Hammer, old,	Davy Bros., Sheffield,	
19	250-lb. Hammer, new,	Bement-Miles & Co.,	
20	250-lb. Hammer, old,	Bement-Miles & Co.,	10
23	Punch and Shears, old,	J. Bertram & Co.,	10
24	Beaudry Hammer, new,	Beaudry Mfg. Co.,	3
27	Flat Iron Saw, old,	C. P. R.,	5
30	Spring Rolls, new,	Craven Bros.,	5
31	Spring Taper Mach., old,	Craven Bros.,	5
34	200-lb. Hammer, old,	Bradley Mfg. Co.,	5
35	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
38	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
39	100-lb. Hammer, old,	Bradley Mfg. Co.,	3
41	Eye Bolt Machine, old,	Wm. White & Co.,	3
43	1½-in. Bolt Header, old,	National Machine Co.,	5
45	Eye Bolt Machine, old,	Wm. White & Co.,	3
47	2-in. Forging Machine, new,	Ajax Mfg. Co.,	10
50	1½-in. Rivet Machine, new,	Ajax Mfg. Co.,	5
51	Forging Machine, old,	Ajax Mfg. Co.,	5
53	Single Shears, old,	J. Bertram & Co.,	3
54	2-in. Upsetting Machine, old,	Ajax Mfg. Co.,	10
56	2-in. Bolt Cutter, new,	J. Bertram & Co.,	3
57	3-in. Upsetting Mach., old,	Ajax Mfg. Co.,	10
59	2-in. Bolt Cutter, new,	J. Bertram & Co.,	3
60	2-in. Nut Burring, new,	Ajax Mfg. Co.,	3
61	3-in. Forging Machine, old,	Ajax Mfg. Co.,	10
63	1½-in. Nut Burring Mach., new,	Ajax Mfg. Co.,	3
64	1½-in. Nut Machine, old,	National Machine Co.,	10
66	Nut Burring Mach., old,	Ajax Mfg. Co.,	3
67	⅝-in. Nut Machine, old,	National Machine Co.,	5
69	1½-in. Bolt Header, old,	National Machine Co.,	5
70	Round Iron Shears, old,	J. Bertram & Co.,	3
72	Round Iron Shears, old,	J. Bertram & Co.,	3
75	1¼-in. Bolt Header, old,	National Machine Co.,	5
76	Round Iron Shears, old,	J. Bertram & Co.,	3
78	2-in. Bolt Header, new,	National Machine Co.,	5
80	Bulldozer No. 6, old,	W. White & Co.,	15
82	Bulldozer No. 5, old,	W. White & Co.,	10
83	Bulldozer No. 6, old,	W. White & Co.,	15
85	Bulldozer No. 4, old,	W. White & Co.,	10
88	Bulldozer No. 5, old,	W. White & Co.,	10
90	Bulldozer No. 4, old,	W. White & Co.,	10
91	Punch and Shears, old,	J. Bertram & Co.,	10
93	2,000-lb. Hammer, old,	J. Bertram & Co.,	
94	1,200-lb. Hammer, old,	J. Bertram & Co.,	
96	2,000-lb. Hammer, old,	Bement-Miles & Co.,	
97	Punch and Shears, old,	J. Bertram & Co.,	15
98	Punch and Shears, old,	J. Bertram & Co.,	10
100	Bulldozer No. 4, old,	W. White & Co.,	10
101	Punch and Shears, old,	J. Bertram & Co.,	15
102	600-lb. Hammer, old,	Davy Bros., Sheffield,	

*All Motors Alternating Current.

MACHINES NOT SHOWN ON DIAGRAM.

1½-in. Bolt Header, old,	National Machine Co.,	5
Fire Brick Crusher, old,	C. P. R.,	
Hydraulic Buckles Press, new,	C. P. R.,	
4,400-lb. Hammer, new,	Bement-Miles & Co.,	
2,000-lb. Hammer, new,	Bement-Miles & Co.,	
2-in. Upsetting Machine, old,	Ajax Mfg. Co.,	
Eyebolt Machine, old,	Ajax Mfg. Co.,	
350-lb. Beaudry Hammer, old,	Beaudry Mfg. Co.,	5
200-lb. Hammer, new,	Beaudry Mfg. Co.,	
Brake Key Rolls, new,		

HYDROSTATIC TESTS OF LOCOMOTIVE BOILERS.

The object of hydrostatic test is to ascertain if the boiler is capable of sustaining some given pressure, and also to test the joints as well as the quality of workmanship. The only means we have of ascertaining with any degree of certainty the safety of a boiler, is by the application of pressure, which should be under conditions as similar as practicable to those of actual work. Let a boiler be ever so carefully designed and constructed according to the best knowledge acquired by careful research and long experience in the strength and disposition of its materials, and let every plate be tested before it is put in, there will still remain an element of doubt as to the actual strength of the boiler, since the material may have sustained injuries in the process of construction which may have escaped detection. In the case of a new boiler, even by a first-class maker, to say nothing of original and hidden flaws in the plates, bars, angle irons and castings, there is always a possibility of defects, such as bad welding, careless riveting, plates burnt in flanging or cracked in bending, and many other defects that may be traced to the want of skill or reckless negligence on the part of the workman. Many cases of dangerous defects which the strictest scrutiny of the completed boiler would fail to detect have been brought to light by the hydrostatic test combined with careful inspection.

The locomotive boiler does not admit of anything like proper examination. The expense of removing the tubes alone would forbid a periodical examination of the shell of boiler, and the water spaces around firebox are almost entirely out of sight, consequently a thorough examination is out of the question. In all cases there is only one means of testing the strength of the boiler, and that is—the application of pressure. We would not consider it practicable to allow a boiler to go through any of our shops for general repairs without having a hydrostatic test. This test to be applied before the boiler is covered, so that any defects that may be found through said test may be properly taken care of. When we consider that a locomotive boiler is constructed with a factor of safety of between 4 and 5, it would be impossible to injure the boiler in any way testing it at a pressure of 25 or even 50 per cent. above its rated working pressure.

The foregoing paper has dealt very largely with the testing of new work. To impress upon the minds of the readers that if such stringent means must be taken to insure a good, substantial boiler, they ought to be willing to confess that it is necessary to repeat this operation at least once each year, as a locomotive boiler, like ourselves, does not get any younger, but older and consequently weaker. From facts above stated the following conclusion should be drawn: That a periodical test at a pressure of at least 25 per cent. above the working load would be necessary and practicable.—*Mr. George Wagstaff, before the Central Railway Club.*

THE FOREMAN'S PLACE.—You men have no business to have your coats off when on duty in your shops unless you are warm. You have no business to take the tools out of a workman's hands to do his work. Your business is to secure results from other men's work. If I find that a foreman boiler maker on my road is doing the work that his men ought to do I begin to think that he had better keep using the hammer and chisel.—*Mr. Robert Quayle, before the Master Steam Boiler Makers' Association.*

UNDER-CONTACT THIRD RAIL FOR THE NEW YORK CENTRAL.

An under-contact third rail, details of which are shown in the accompanying illustrations, has been developed on the New York Central, and has several important advantages over the top-contact rail as regards safety and economy. The design originated with Mr. W. J. Wilgus, vice-president of the New York Central, and Mr. F. J. Sprague, and was perfected under the direction of Mr. Edwin B. Katte, electrical engineer of the New York Central.

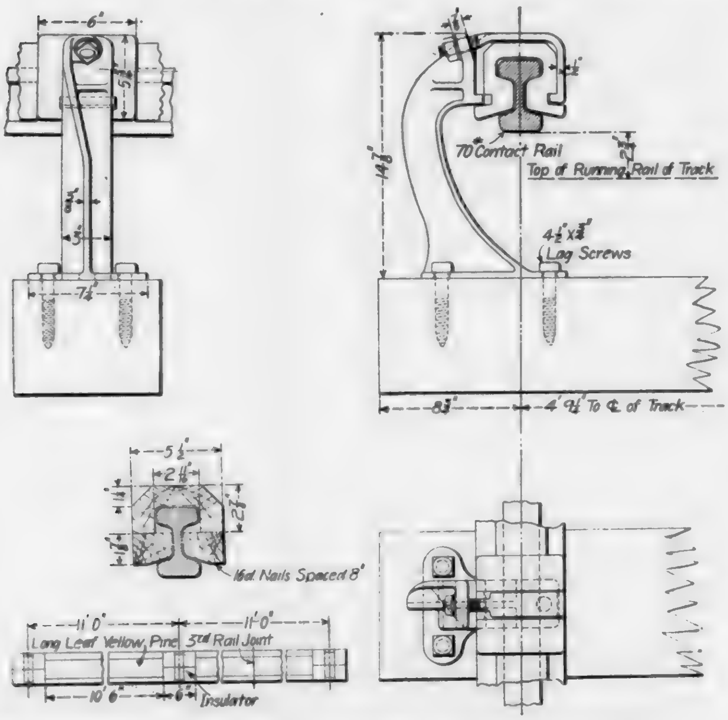


FIG. 1—DETAIL OF SUPPORTING BRACKETS AND WOOD PROTECTION, NEW YORK CENTRAL TYPE OF THIRD-RAIL.

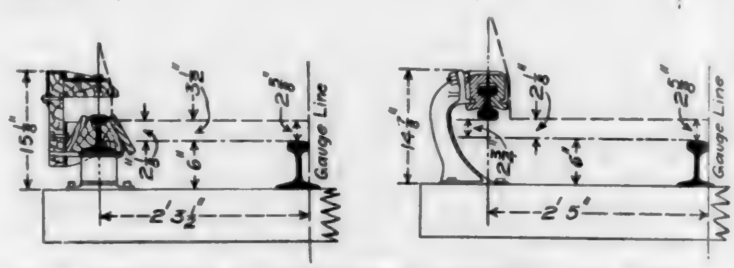


FIG. 3—COMPARISON OF CLEARANCES OF TOP-CONTACT AND UNDER-CONTACT THIRD-RAIL INSTALLATIONS.

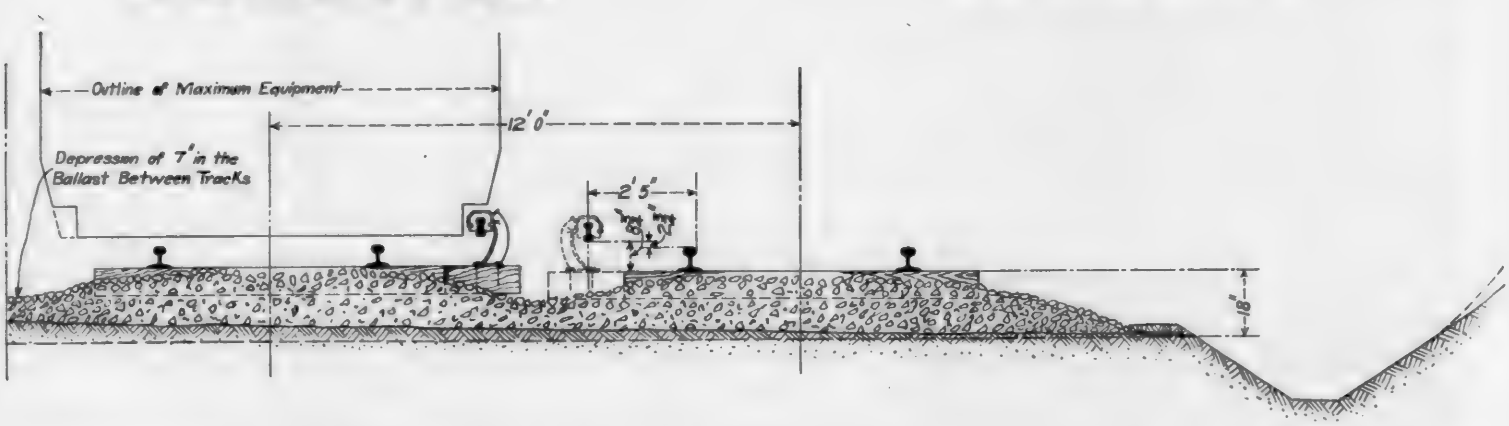


FIG. 2—HALF CROSS-SECTION OF STANDARD FOUR-TRACK ROADBED SHOWING LOCATION OF THIRD-RAIL.

The third rail is of a special bullhead section, 70 lbs. to the yard, and has a composition which gives it a high electrical conductivity. It is supported by cast iron brackets strongly ribbed, which are bolted to the ends of extension ties spaced 11 ft. apart. Insulators fit loosely over the top of the flange and web of the rail, thus allowing for some vertical play and providing for longitudinal motion due to the expansion and contraction caused by changes of temperature. A clamp fits around the side and top of the insulator, and is bolted to the top of the bracket. A glazed vitrified clay insulator has given the best results on the experimental track at Hoffmans, N. Y. The top and both sides of the rail to within ⅞ in. of the bottom are protected between the supports by three pieces of long leaf yellow pine, as shown. The third rails for a four-track roadbed will be located as shown in Fig. 2.

The relative location and appearance of the Subway or Long Island Railroad type of third rail installation and of the New York Central type is shown in Fig. 3. The center of the third rail is located 1½ ins. farther out on the New York Central type, but this will not interfere with the interchange of equipment, as a suitable shoe can be arranged which will automatically pass from one type of third rail to the other.

This type of third rail is thoroughly protected against accidental contact of any kind, and the trackmen may work with more freedom and use their time to better advantage than where the top-contact third rail is used. The cost of maintenance should be considerably less than for the top-contact type, since the contact surface is protected from snow or sleet, and the rail is less liable to corrosion; the board protection has a continuous support and is less apt to crack and warp; there is less strain on the insulators, as the pressure of the shoe acts against instead of with gravity. There is also a much greater space between the lower part of the rail and the cross-tie, and therefore less liability of leakage of current, due to the accumulation of snow, ice and ballast. The under-contact type requires only 7,600 parts per mile, as against 24,500 for the top-contact type, and this should reduce the cost of maintenance of the former. The under-contact type costs $4,100 per mile, as compared to $4,325 per mile for the top-contact type, or a saving of $225 per mile in favor of the former.

THE SELECTION OF ELECTRIC POWER FOR SHOPS.

The following reasons, underlying the selection of the electric power apparatus for the Readville shops of the New York, New Haven & Hartford Railway, are taken from a paper read before the New England Railroad Club by Mr T. W. Adams, general foreman of the shops.

After determining on the use of the electric drive and having also decided it advisable to deliver the power to the shops in the form of alternating current, it then became a matter for very careful consideration as to whether alternating or direct current motors and lights were best suited to the particular local requirements, and in view of the isolation of the different machines to be operated, as to whether it was advisable to drive each machine with its own individual motor or to group them and so install the motors that one motor would operate a number of machines located in its own immediate vicinity. The capability of alternating current motors to handle heavy overloads for short periods without any ill

effects allowed of the installation of much smaller motors than would have been possible had direct current motors been used, and this made a very material gain in first cost of the motor equipment. The entire absence of commutators and brushes made the cost of maintenance also much less and, due to the inflammable nature of a great deal of the work, this last feature also made the alternating current motors highly desirable.

The transfer table required the use of a variable speed motor and it was found desirable to use a direct current motor which could be designed to give a much more gradual speed variation than was practical with the alternating current motors.

The matter of determining how far the subdivision of the power should be carried was also an item of very careful consideration and was approached from both extremes, namely, first, the individual connection of each machine to its own independent motor and consequent elimination of all shafting and belting. Second, the delivering of the power from the power station to one or two large motors so located as to deliver the power to the machines through the medium of long lines of shafting and belting was carefully considered. The first method was found to entail a first cost of more than was commensurate with the advantages obtained, and from the fact that small motors were less efficient than large motors, it then became necessary to determine if this loss in efficiency was as much as would be represented by the shafting and belting required by the second proposed method. It was found that the cost of the shafting and belting plus the cost of the large motors, while being less than the first cost of the first method, represented an efficiency loss which would represent more than the interest on the difference in the investment, and the two methods were brought nearer together, step by step, until a compromise of both was finally adopted, resulting in a very reasonable first cost and maximum efficiency in operation, which also resulted in a minimum cost of maintenance.

This compromise was to drive individually such machines as would occupy an isolated position and which were used more or less intermittently, and when used consumed power practically at full output of the motor by which it was operated (this plan was followed in blacksmith shop), and operating in common from one motor such machines as could be conveniently grouped without necessity for the use of large or long shafts and belts, and such machines as were operated with varying power, thus being able to use smaller motors than the aggregate maximum requirements of the several machines would indicate as being necessary, from the fact that the case would seldom, if ever, occur when each machine would call for the maximum power at the same instant, and, even if they should, it would occur so seldom and for so short a period as to be a matter of very little moment. This also resulted in reducing the first cost and increasing the efficiency of the system as a whole. It was finally decided that the polyphase motors were by far the most feasible and best solution of the question. Reliability, adaptability and simplicity were potent factors in their favor, and combined with the facts that they could be used on a long distance transmission and were free from sparking and moving contacts clearly proved the superiority of the polyphase system for this installation.

MIKADO TYPE FREIGHT LOCOMOTIVES.

NORTHERN PACIFIC RAILWAY.

In this journal in January of this year, page 5, the 2-8-2 type freight locomotives, built at the Brooks works of the American Locomotive Company, were illustrated and described, these locomotives being heavier and more powerful than any previous design for this road. In the description referred to, one of the single expansion 2-8-2 type locomotives was illustrated, and the fact was mentioned that six out of nineteen built at that time were tandem compounds. The accompanying engraving illustrates one of the second lot of tandem compounds which has just gone into service, being very nearly identical with the first order of this type and size. Reports of excellent performance of the Mikado type on this road indicate the wisdom of its selection, one advantage being a deep-throated fire-box, which is exceedingly advantageous in bad water districts. There is also a more favorable distribution of weight than can be obtained with the 2-8-0 type. The present design may be compared with the description already referred to. This tandem compound is exceeded in weight on driving wheels by only seven locomotives in our list of large locomotives, which appeared in May, 1905. These compounds have a cylinder ratio of 1 to 2.56. The accompanying table presents the usual list of dimensions and ratios:

GENERAL DATA.

Gauge	4 ft. 8½ ins
Service	Freight.
Fuel	Bituminous coal.
Tractive power	44,300 lbs.
Weight in working order	271,000 lbs.
Weight on drivers	207,000 lbs
Weight of engine and tender in working order	417,500 lbs.
Wheel base, driving	16 ft. 6 ins.
Wheel base, total	34 ft. 9 ins.
Wheel base, engine and tender	63 ft. 1 in.

FREIGHT LOCOMOTIVE, MIKADO TYPE—NORTHERN PACIFIC RAILWAY.

RATIOS.

Tractive weight ÷ tractive effort	4.67
Tractive effort x diam. drivers ÷ heating surface	696
Heating surface ÷ grate area	92.1
Total weight ÷ tractive effort	6.11

CYLINDERS.

Kind	Tandem compound.
Diameter and stroke	19 and 30 by 30 ins.
Piston rod, diameter	4¼ and 3½ ins.

VALVES.

Kind	14-in. piston and slide.
Outside lap	H.P., 1 in.; L.P., 1⅛ ins.
Inside clearance, low pressure	¼ in.
Lead in full gear	H.P., 1-16-in. positive; L.P., 1-16-in. negative.

WHEELS.

Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 and 9½ by 12 ins.
Engine truck wheels, diameter	30½ ins.
Engine truck, journals	6½ by 12 ins
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.

BOILER.

Style	Radial extended wagon top.
Working pressure	200 lbs.
Outside diameter of first ring	75¾ ins.
Firebox, length and width	96 by 65 ins.
Firebox plates, thickness	⅝, ⅜ and ½ in.
Firebox, water space	4½ and 4 ins.
Tubes, number and outside diameter	374, 2 ins.
Tubes, gauge and length	No. 11, 19 ft. 6 ins.
Heating surface, tubes	3,798 sq. ft.
Heating surface, arch tubes	9 sq. ft.
Heating surface, firebox	200 sq. ft.
Heating surface, total	4,007 sq. ft.
Grate area	43.5 sq. ft.
Exhaust pipe	Single
Smokestack, diameter	20 and 24 ins.
Smokestack, height above rail	15 ft. 10¼ ins.
Centre of boiler above rail	118 ins.

TENDER.

Tank	Water bottom
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,000 gals.
Coal capacity	12 tons.

LOCOMOTIVE TESTS WITH 250 LBS. PRESSURE.

Experiments carried out by Dr. W. F. M. Goss at Purdue University, under the patronage of the Carnegie Institution, developed exceedingly important facts concerning the use of 250 lbs. boiler pressure in locomotives. These tests are recorded in a preliminary manner in an article by Dr. Goss in the *Railroad Gazette*. It will be remembered that the Rock Island System in settling upon a boiler pressure to be used in their standard locomotives determined to adopt 185 lbs., preferring to sacrifice, if necessary, in economy to a slight extent, for the sake of avoiding the serious boiler troubles which have been increasing since pressures were augmented to 200 lbs. and over. The tests at Purdue tend to show that there is likely to be no sacrifice in efficiency due to this reduction of pressure and the possible result of the investigation is to attract attention chiefly to the advantages of lower boiler pressures.

The work at Purdue was directed toward a determination of a logical basis for establishing steam pressures in single expansion locomotives. It will be remembered that the experimental locomotive at Purdue was designed and built to carry 250 lbs. pressure with a view of ultimately determining this question.

Prior to the complete publication of the records results obtained when operating with a full open throttle under a pressure of 240 lbs. are reviewed. Some of the figures are given in the accompanying tables.

TABLE I.

Steam per I. H. P. per hour.				
	Revolutions	Cut-off, per cent. of stroke		
Miles, per hour.	per minute.	15.	20.	27.
20	97	26.29	25.33	24.08
30	146	25.48	24.44	.....
40	195	24.16	23.86	.....
50	244	24.97	.....	.....

TABLE II.

B. T. U. per I. H. P. per minute.				
	Revolutions	Cut-off, per cent. of stroke		
Miles, per hour.	per minute.	15.	20.	27.
20	97	442.3	425.8	405.5
30	146	424.9	407.4	.....
40	195	405.9	398.0	.....
50	244	418.1	.....	.....

These figures show the full range of operation under the pressure stated and it is shown to be possible to run at 40 m.p.h. with a 20 per cent. cut-off, but an attempt at 50 miles with the same cut-off failed for lack of steam. With a 27 per cent. cut-off 20 m.p.h. was possible, but an attempt at 30 miles failed. This represented a development of 500 to 575 h.p., a heavy load for a 16 x 24-in. cylinder locomotive and a boiler having but 1,322 sq. ft. of heating surface. Because of the importance of these experiments the following observations by Dr. Goss in the article referred to are reproduced:

"With reference to the economical results, it appears that the average steam consumption under eight different conditions of running is 24.57 lbs. per h.p. per hour, the best value being 23.86. From tests previously run, it is known that the performance for 180 lbs. pressure is 24.08 lbs., from which it appears that the performance for 180 lbs., when compared with that at 240 lbs., presents a difference of but .22 of a lb.; a difference too small to constitute a strong argument in favor of the higher pressure.

"A more careful study of all the data obtained indicates that further increase of pressure in locomotive service is not desirable, and strongly suggests the possibility that even present-day practice may exceed limits which in the end will be found most economical.

"It is well known that theoretical considerations show that the gain in economy to be secured from increasing steam pressures above 180 lbs. is at best small and the experimental facts which have been quoted indicate that in practice there is failure to realize all that theoretical considerations promise. The reason for this is to be found in the practical difficulties to be met in maintaining all parts of a locomotive tight under very high steam pressures. A boiler leak, either of steam or water, so slight as to attract little attention may easily amount to 100 lbs. or more per hour. A few such leaks materially impair the performance of the locomotive. The data of many tests have been entirely abandoned because of the existence of some conditions which upon the road would have attracted no attention, but which in the laboratory have been regarded as sufficient in their effect to entirely vitiate the results of the tests. Notwithstanding the fact that tests were run on alternate days only, leaving time for boiler makers and machinists to do their work, it was found impossible to keep the boiler perfectly tight or to prevent entirely the appearance of steam at the glands and drips about the cylinders. When it is remembered that this statement applies to a locomotive in the laboratory where it could be well cared for, it is not difficult to surmise the significance of such leakage as occurs from a locomotive on the road. Moreover, the benefits to be derived from higher pressure can only appear when the locomotive is working, while a portion of the leakage proceeds throughout the period during which it is under steam.

"It was found, also, in running tests at 240 lbs. that minor difficulties constantly presented themselves. For some of these, feedwater was responsible. The water used at the laboratory is from a driven well and contains some lime and magnesia. When used in stationary boilers carrying moderate pressure, it does not ordinarily form a hard scale but deposits a sludge which may be easily washed from the boiler. Its use for six years in the boiler of Purdue's earlier locomotive (Schenectady No. 1), for which the safety valve was set at the low pressure of 140 lbs., resulted in the formation of very little scale. During this period, a year or two elapsed between the visits of a boilermaker, and the boiler was perfectly tight practically all of the time. With this satisfactory record, when using low steam pressure, it is significant to note that the present locomotive (Schenectady No. 2), using the same water but carrying a higher steam pressure, has required the frequent attention of a boilermaker. After 30,000 miles running, new side sheets were inserted, and the leakage of tubes and staybolts have been of constant occurrence. It appears certain that the presence of solids in the feedwater which at the lower pressure gave little trouble, has seriously affected the operation of the plant at higher pressures.

"In addition to boiler defects there has been constant trouble with injectors and check valves. The injectors employed, while especially designed for the high pressure service, fill up very rapidly, due doubtless to the high temperature of the water delivered. It has been the practice when operating at 240 lbs. to clean the injectors between each run, but even under these conditions, tests have been lost through the failure of both injectors. It has been found that injector tubes will fill with lime so rapidly as to become inoperative after an hour's run, and check valves which have been clean at the beginning of a test have filled so that they would not close in the course of a single test. The fact seems to be that much of the solid matter which at lower pressure goes through the injector and passes the check into the boiler, is, under very high steam pressure, deposited in the injector and feedpipe.

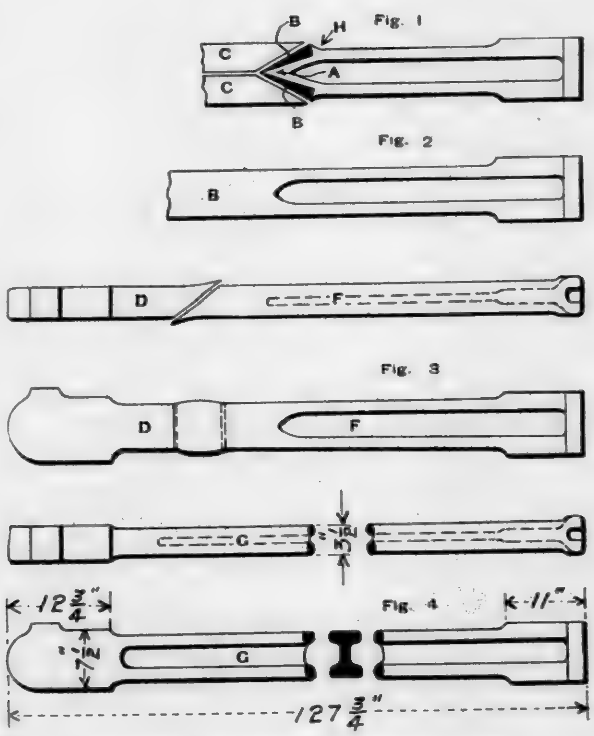
"In view of these difficulties, it was finally determined to improve the feed water. This was done by drawing water from a cistern receiving return from the heating coils of the laboratory building from which source it was possible to obtain from two-thirds to three-quarters of the total feed needed. The change greatly increased the certainty of operation though even the small amount of raw water then used manifested itself in the injectors and check valves, which still required to be cleaned after every test. It is in fact quite likely that a determination of the most desirable steam pressure for locomotive service must depend not only upon the economical performance of the engines and boiler, but also upon the purity of feedwater supply. In our western country, where feedwater necessarily contains a considerable amount of solid

matter, it will be found that the difficulties in maintaining and operating a boiler multiply with each increment of pressure.

"While a more precise statement of conclusions must await the full development of the present research, it may safely be said that an attempt to increase beyond limits now common the steam pressure upon American locomotives can only lead to disappointment. The possible gain is small and is likely to be more than neutralized by increased leakage while the difficulties of maintenance and operation multiply. It is not improbable that the final results will show that 200 lbs. which is a generally accepted standard of to-day is in our western country too high for best results."

FORGING AND REPAIRING LOCOMOTIVE MOTION RODS.*

In the past three or four years, what is known as low carbon steel has taken the place of iron in many cases to produce side and main rods as well as rod straps, consequently, the old method of forging and repairing these members, in a measure, has become obsolete and new methods have been adopted to meet the changed conditions. We are all familiar with the old method of producing these members from the best quality of



REPAIRING LOCOMOTIVE CONNECTING RODS.

scrap material. The method of utilizing scrap steel, similar to the old method of using scrap iron, is not yet in evidence for producing such important members of the locomotive as side and connecting rods, straps, etc. These members are forged from large steel blooms made for the purpose. Much more care has to be taken in forging such motion work from steel blooms than the old method of forging iron for the reason that steel is of a crystalline structure. The least imperfection in the steam hammer may cause a slight check in forging from the ingot or the slightest overlap worked into the forging will produce the nucleus for a break from vibrating strains when in service. The slightest nick with a sharp chisel on the finished surface of a steel rod will produce similar results. Many failures of steel rods have come to my notice in the last two years from the causes mentioned. Such defects may be produced in forging iron rods, as this material is of fibrous structure. The injury is not so pronounced as in steel, as one or two outside fibers are effected only, leaving the inside fiber intact, consequently the injury will not work its way into the metal to such an extent as it will with a metal of a crystalline structure.

Steel rods came into use in the Sacramento shops two or three years ago. Since that time I have had to repair many steel rods. In many cases, on examination, a slight check would present itself on the rib of a grooved steel rod. If the rod is low in carbon and will stand a high heat, the slight defect is easily remedied by cutting out the defective portion and welding a piece of good iron in the cavity by taking separate heats. If properly done this will prevent the original fracture from working into the rod from vibrating strains. The method practiced by many smiths of putting in what is termed a "Dutchman," from my point of view, is a very bad practice. This method is accomplished by splitting the defective portion and driving a wedge of iron in the split, then taking a welding heat on the upper surface of the rod and wedge and hammering the wedge and welding the iron over the defect. This simply hides the defect. I recently had a rod cut where a defect was repaired by this method. The sections of the rod showed the wedge in perfect shape, excepting a small portion of the surface.

We have many of these steel parallel rods coming into the shop with the defect so pronounced that it becomes necessary to cut the fractured portion off and put on a new end. Formerly the method practiced was to fill in the grooved portion of the rod with good iron, as well as the projecting ribs, continuing the iron portion about 8 in. from the broken section, then welding on the iron portions by the usual method of male and female scarfs. This method was not entirely satisfactory as we invariably found a slight defect on the surface of the grooved portion, when the groove was planed out of the repaired section.

Recently the Southern Pacific has been changing the heavy compound engines to simple engines. It became necessary to lengthen the main steel connecting rods; this is accomplished by welding on new ends. The original method as explained was not satisfactory. I adopted the method as shown in Figs. 1, 2, 3 and 4. We cut off the end that had to be renewed. The end of the old portion of the rod to be welded was upset with a battering-ram. Then by means of a steam hammer a point was formed on the end of the rod as shown at A, Fig. 1; this produces a round corner at H. To overcome this we raise a fillet at this point by cutting into the metal slightly and driving the metal back with a fuller. We then lay two pieces of iron, B B, on each side of the V-shaped end of the rod, firmly welding them to the steel. Now we have the end of the rod shod with iron. This being accomplished, we have iron to iron welds and can get high heats without bringing the steel to an injurious heat. We now bring our two pieces, C C, to a welding heat in separate fires, welding them on to the surface B B under the steam hammer. Another welding heat is now taken for the purpose of forming a perfect union of all of the parts as shown at B, Fig. 2. The remainder of the work is done by the ordinary method of lap welding under the steam hammer as shown at D F, Fig. 3. The portion D is forged by the steam hammer from the best scrap iron obtainable. The rod being finished as far as the forging is concerned goes to the machine shop to have the new iron portion finished and grooved as shown at G, Fig. 4. When the rod is being finished the slightest defect in the welded portion will be discovered.

There have been 40 rods welded by the above method in the Southern Pacific shops in the last eighteen months. A slight defect in the welded portion was found in one case only. Not a single rod has failed in service.

*From a paper by Mr. S. Uren, read before the National Railroad Master Blacksmiths' Association.

RESULT OF MASTER MECHANICS' LETTER BALLOT.—The secretary of the Master Mechanics' Association advises that the recent letter ballot resulted in the adoption of the specifications for locomotive driving and truck axles, the specifications for locomotive forgings and the specifications for steel blooms and billets for locomotive forgings.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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MR. GEORGE M. BASFORD.

It is with deep regret that the announcement is made of the retirement of Mr. G. M. Basford as editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL. For nearly eight and a half years he has been in charge of its editorial management, and it is unnecessary to speak of the character and the earnestness of his work or of its effect in placing the paper in its present position among the technical journals. In laying aside journalistic work, Mr. Basford's name may be placed with those of Barnes, Wellington, Forney, Marshall and Prout for years spent in unstinted devotion to a profession which is difficult and not too full of encouragement. All of these men have inspired many others, and by words and helpful acts have urged and aided young men toward advancement and improvement.

Mr. Basford has fought the battle of the motive power department consistently and systematically, maintaining that it should be properly and fittingly recognized because of its real importance in the organization of railroads. His views on this subject are not new to the readers, but perhaps the reasons for his opinions on the subject of apprenticeship are not known. After several years of service in various kinds of engineering work he entered the Massachusetts Institute of Technology and was graduated in 1889 in mechanical engineering. He entered the shops of the Boston & Maine as a laborer, and there he began his study of apprenticeship and recruiting. Later he went to the Chicago, Burlington & Quincy as a draughtsman at Aurora, and afterwards served in various capacities in the mechanical departments of the Burlington, the Union Pacific and the Chicago, Milwaukee & St. Paul roads. He served the last mentioned road as signal engineer, and afterwards spent several years in the signal business in Chicago. In January, 1895, he became engineering editor of the *Railway and Engineering Review* in Chicago, where, in two years, he became known by his work.

In May, 1897, Mr. Basford became editor of this journal succeeding Mr. M. N. Forney and Mr. W. H. Marshall. The manner in which he handled his difficult task is told by the paper itself, and requires no comment or praise. Mr. Basford's standing among the railroad officials is shown by the testimonial given him two years ago and the high regard in which he is held by the younger railroad men is best seen in the constant stream of these young men to the editorial rooms of this paper when they have troubles to tell about or advice to ask. It is understood that in his new work he is to continue much that he began in his newspaper work, and that among other things, he is likely to be called upon to put into practice his ideas as to apprenticeship.

His associates, including the proprietor of the AMERICAN ENGINEER, wish him the success which he is sure to win in the new field, and congratulate the American Locomotive Company upon securing him.

Railroad repair shops probably use more machine tools than any other one metal working industry in this country, and yet we find that only a few of the machine tool builders have devoted any special study to this field. Those who have done so have found the railroads ready to co-operate with them in their efforts to improve or adapt their tools to the work. The larger number of machine tool builders, although they have sold many tools to the railroads, have never made any special effort to follow them up and see what class of work they were doing or to find out what satisfaction they were giving. Some of them have sold their tools to the railroads through agents, and cannot even tell at what shops they were installed. The purpose of this editorial is not to give the impression that the machine tools used in a railroad repair shop should deviate greatly from the standard machines, but rather that often a few slight changes from the standard or the addition of special attachments will greatly improve the output of the machine for special work, and will afford much more satisfaction to the user. A system for following up the tools could be installed and conducted without any great amount of expense, and would certainly repay for itself many times over if intelligently handled. A case was recently called to our attention where a machine tool builder had occasion to visit a certain railroad shop, and after examining some of the work which was being handled on one of his standard machines was enabled to make certain changes on a new machine which he was about to install which made it possible to practically double its capacity over the standard machines for this class of work.

A correspondent speaks plainly on the subject of water purification in a recent letter which we would like to print in full. He says that the time has passed when the motive power man can safely be tied hand and foot and asked to give "results" with bad water. He says it is now too late to say bad water was in the beginning, is now and ever shall be. "How many roads are spending thousands of dollars on the effect and not a cent on the cause?" "When we consider the increased demands on the equipment, increased wear and tear because of increased weight and heavier business, it is pertinent to ask if we may fairly expect to secure the returns looked for from the vast sums of money invested in new shops and improvements of like nature, unless the policy is changed to deal only with the effect and ignore the cause." While large sums have been spent by some roads in improving their water supply only a beginning has been made and it is in this direction, that of attacking the cause, that the improvement of the future lies rather than dealing with the effect. To deal with the water purification question effectively has proved to be excellent business policy both from the standpoint of the locomotive operation, and also to relieve the shops and roundhouses of a vast amount of work which increases with the weight of locomotives and the increased demand upon them.

A machine tool manufacturer with a broad smile on his face, recently stated to the writer, who was examining a newly designed engine lathe, which was remarkable for its compactness of design and for the convenience with which the operator could control its various movements, that the next improvement would be to furnish a chair for the use of the operator which would travel with the lathe carriage and could be swung back under the bed when not in use. The improvements which have been made in machine tool design during the past few years are wonderful, and it would seem that the limit of development has almost been reached in the design of the standard machines. The machine tool builder has done his part. It is now up to the shop manager to produce results and to place his methods of handling the men and the work on the same high plane as the design of the modern tools. If we may judge from the results which have recently been accomplished in some of the more progressive shops the possibilities of increased output and greater economy, due to the introduction of improved methods of operation, are even greater than the combined results due to the modern machine tools, high speed steels and improved methods of driving machine tools. Mr. H. T. Bentley in his valuable paper on "The Organization of Railway Shop Forces" on another page of this issue, emphasizes this very strongly in saying that he would prefer and undertake to do more work with comparatively old shops with old tools, but with a good organization than with a modern shop with a full complement of new tools and a poor organization.

REPORTING LOCOMOTIVE DEFECTS.

"No steam, right injector not working, pound on the right side, bad coal." Such reports as these are often made by enginemen.

It is impossible to keep locomotives up to proper condition with reports of this character, because roundhouse forces are not given sufficient information to correct the difficulties. When an engine is cold in the roundhouse it is impossible for the men to discover the exact cause of the trouble and in many cases the necessary work is not done.

Many motive power officials complain of the indefiniteness of the reports of enginemen and they say it has grown worse with the increase of pooling. Undoubtedly if the men realized the importance of it they would be more explicit in their statements. On some roads such reports are not permitted, the men being required to know where the pound occurs, what the trouble with the injector is and why the engine does not steam, or if they cannot tell positively they are required to give an intelligent opinion.

It is not unreasonable to expect an engineer to know quite definitely what is wrong, and where such difficulties occur it seems fair to predict that great good would result from closer relations between the traveling engineer and the men. Would the owner of a $20,000 horse accept from his driver a statement that the animal was lame, or otherwise not right? He would certainly be justified in expecting the man to take sufficient interest in his charge to know where he was lame or what was wrong. It cannot be believed that the men who are entrusted with modern locomotives are not capable of satisfactory diagnosis.

"Poor coal" is generally accepted as a reason for engine failures on most roads. There seems to be some mystic power in these two words. With proper management of the fire, "poor coal" should never lead to an engine failure. Are the locomotives designed for the coal they must use? Do the firemen receive the amount of instruction in the use of fuel that the importance of their work requires? Does the engineer feel sufficiently responsible for or interested in the work of his fireman to give him the benefit of his experience? Anything which will increase the interest of the men in their work will help these matters along wonderfully. In Europe premiums to the engineer and fireman have accomplished wonders in these directions.

AN UNDESERVED SLUR.

"We wonder if the railway presidents do not often wish that the electric motor had never been invented."

This soliloquy, quoted from an editorial in a well-known electrical journal, reflects a view of the opinion of steam railroad officers which does little credit to the rampant advocates of electric traction. If these advocates do not find progressiveness among railway presidents, where do they find it? Who is making better use of electric motors than the steam roads, and what class of men is more ready to adopt anything new and radical, providing it will pay its way financially?

The change from direct steam to electric traction on the Lancashire & Yorkshire, in England, those of the Baltimore & Ohio in its Baltimore tunnel, and the work of the Pennsylvania and New York Central terminals in New York eclipse all other electrical projects in boldness and in extent. In these instances the steam railroad men have taken the initiative, and the electrical men have responded, and responded ably. Electricity was sought because it was needed, and the railway presidents were the first to see the need. They presented problems which the electrical people considered experimental in that they could turn to no precedent or example.

It is idle to advocate electric motors for heavy traffic conditions generally to-day. Everybody knows that it will not pay to electrify a main line division having comparatively few train units. The determining factor is the traffic. Instead of belittling the men who have made American railroad systems, those who understand electric traction can expend their energies to better advantage by preparing for the rush which the steam railroad men are nearly ready to present.

DRAFTSMEN.

Of late there has been an increased demand for competent draftsmen, which indicates a marked change and improvement in the status of the draftsman. This is noticeable not only in the number of inquiries for good men, but in salaries which are being offered them. The salaries offered are none too large, but they are much better than those of a few years ago. There is probably no factor in the motive power department capable of such improvement as the drafting room. The strongest motive power officials lean hardest upon their drafting rooms and a study of their needs leads to the conclusion that the possibilities of the draftsman are not by any means exhausted.

Some time ago a motive power officer said, "The greatest trouble I find among the draftsmen is their inability or helplessness in doing things. All seems to go well enough if I put in their hands every particle of information, but should one item be omitted they seem unable to know where to look for the missing data."

It has been shown to be possible for the drawing-room as a department to not only walk alone but to be a dealer in very important problems. It is quite possible that those who do not find their draftsmen a necessity of the most important kind may be themselves to blame. The draftsman is not in any sense a necessary evil. He is intelligent, and is trained to think and to plan. He is most valuable if he is encouraged by being treated as a part of the working organization. If he is trusted and is given responsibility he grows to be a vital element as a constructive factor in the organization. The draftsman occupies such a position on many roads but on many others, and probably a large majority, is not treated in such a way as to bring out his possibilities. Some superintendents of motive power do not derive the full measure of support and assistance which is available by the complete development of the draftsman's position, and hence the development of the draftsman is often far short of what it ought to be. Draftsmen, however, ought to see a great deal to encourage them in the improvements of the past few years.

PRODUCTION IMPROVEMENTS.

TRUCK FOR DRIVING WHEEL TIRES.—L. S. & M. S. RY.

The truck shown in Fig. 1 affords a very safe, quick and convenient means of handling driving wheel tires. With this device two men can easily handle the largest size tires without difficulty and with no liability of personal injury. Without the truck six men are usually required to handle one of the large tires in the yard, and four are required for handling it inside the shop. The illustration shows an 80-in. tire on the truck. To pick up a tire the hook shown just below the axle, and which serves to stiffen the truck when loaded, is unhooked, the truck is moved over the tire, the truck handle is lifted a short distance and a 1-in. pin is passed through the uprights just below the rim of the tire. When the truck handle is lowered the tire is raised off the ground, as shown.

MANDREL FOR DRIVING BOX BRASSES.

A mandrel for driving box brasses is shown in Fig. 2. The practice is to adjust the first driving box brass of a lot on the mandrel by manipulating the set screws. After the first one is set other brasses of the same kind are mounted by dropping them on the set screws and tightening up the end nut. To adjust the mandrel and set the first brass ready for turning requires about ten minutes, and subsequent brasses of the same kind are mounted in about three minutes. The time required for mounting, taking rough and finishing cuts and dismounting the brasses after the chuck has been set for the first one is about eighteen minutes. The mandrel illustrated is the larger one of two sizes which are in use.

TOOL FOR REMOVING PISTON RODS FROM CROSS-HEADS.

A very substantial and efficient device for removing piston rods from cross-heads, and one that is well adapted to stand the rough usage which the nature of the work demands, is shown in Fig. 3. The pin portion of this device replaces the cross-head pin after it is removed. The slight taper of the key makes the device very powerful.

EXPANDING REAMERS FOR ROD BUSHINGS.

The expanding reamer for rod bushings, shown in Fig. 4, is set 1-64-in. larger than the crank pin, and the bushing is reamed to a smooth, finished surface and accurate size in much less time than by other methods. The bushings are, of course, rough-bored before being placed in the rod.

We are indebted for drawings and information to Mr. C. W. Cross, master mechanic of the Lake Shore & Michigan Southern Railway at Elkhart, Ind.

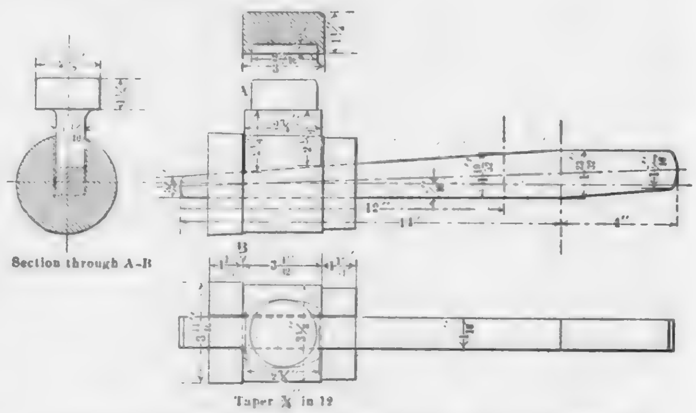


FIG. 3—TOOL FOR REMOVING PISTON RODS FROM CROSS-HEADS.

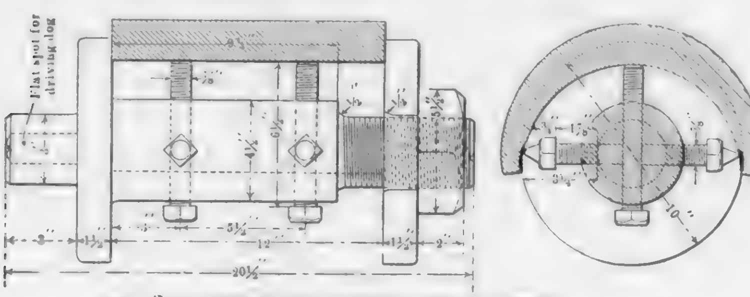


FIG. 2—MANDREL FOR DRIVING BOX BRASSES.

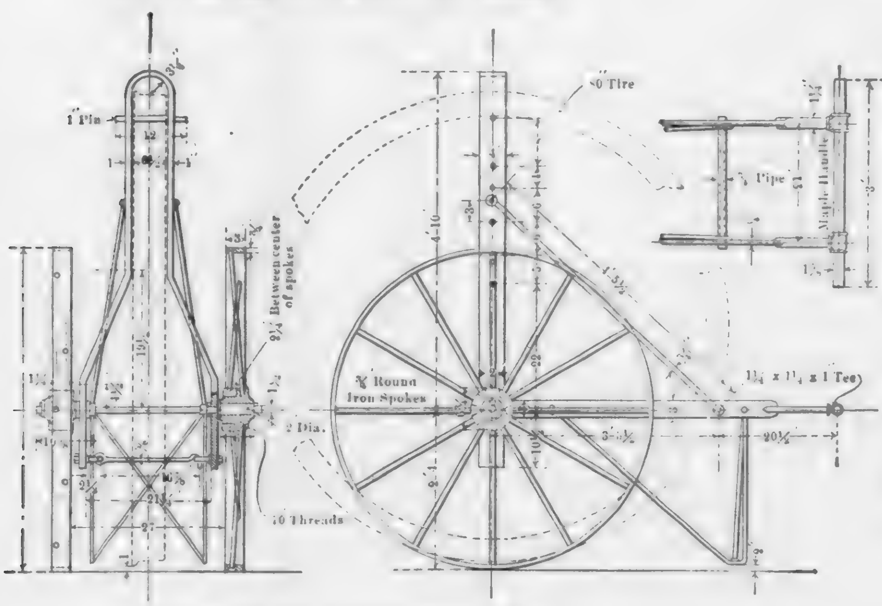


FIG. 1—TRUCK FOR DRIVING WHEEL TIRES.

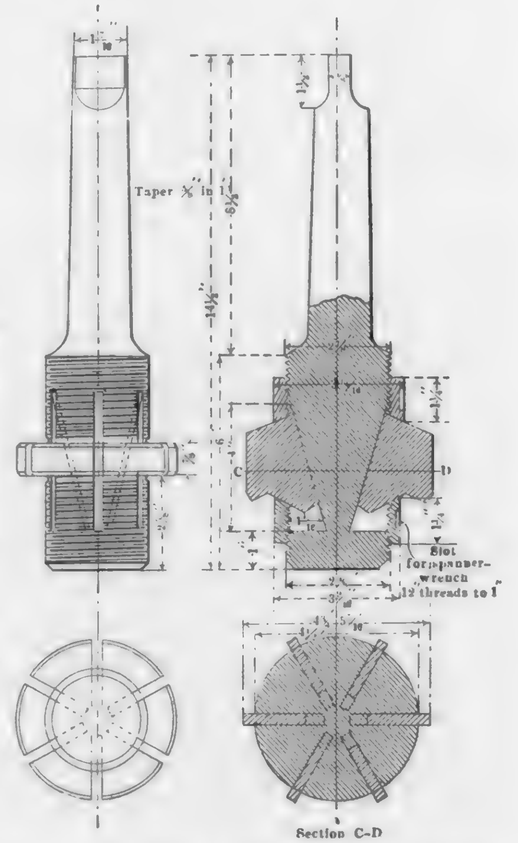


FIG. 4—EXPANDING REAMER FOR ROD BUSHINGS.

AUTOMATIC DOOR OPENERS.—One of the best labor-saving devices we have found for a long time is the pneumatic fire-door operator. The operating lever is placed in such a position on the deck of the cab that the fireman by placing his foot on it opens the door, by moving his foot away the door is closed, thus insuring the swinging of the door between shovels of coal and also preventing chilling of the flues by permitting the door to remain open longer than is necessary. A device of this kind should be applied to each locomotive.—*Traveling Engineers' Association.*

RESULTS OF WATER PURIFICATION.

Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, in speaking before the New York Railroad Club, said that ten purifying plants were now in operation on that road, and five more were to be installed. Treated water has been used in a sufficient degree during the past eighteen months to make the observations reliable, and it is now well understood what can be expected from the investment. The water supply is taken from 6 different rivers, no two presenting the same analysis. The greatest trouble that has to be met is acidity, at times and places being as high as 35 grains to the gallon, and one-third of this being free sulphuric acid. The second disturbing elements are sulphates of lime and magnesia, and the third are carbonates of lime and magnesia.

Our past experience has demonstrated that we have the worst water from the first of August until about November 1st, or until the heavy fall rains commence. During this period the river supply is largely made up of drainage from the coal mines, and during one particularly bad season, prior to the use of treated water, three shifting locomotives, new and direct from the manufacturers, were sent to one point in the acid district in June. Early in September of the same year every tube in the three locomotives was removed and scrapped, being totally unfit for further service

Before treated water was used it was not an uncommon occurrence to find in locomotives that had worked largely in the districts where incrusting solids predominated, such an amount of mud and scale as to entirely obstruct all circulation in portions of the cylindrical part of the boiler, and there would be from 15 to 40 tubes collapsed and worthless. During the latter part of each year troubles multiplied rapidly, and on such locomotives as were not filled up with scale and burning out, the sheets and tubes were being eaten up with acid and failures on the road were not the exception, but the rule.

Before treated water was used it was the rule to wash out boilers once for each seven to ten days of service. After the treating plants were installed, the time between washouts was gradually lengthened until, under favorable conditions, where the movements of the power could be controlled and nothing but treated water provided, they were run for forty-five days between the times the washout plugs were removed. However, the materials which were used to soften the water, precipitate sludge, and neutralize the acid, causing the boilers to foam, making it necessary to change the water at intervals of about five days. This feature is easily taken care of by equipping the engine-houses with facilities for hot water boiler washing, and when properly designed the water can be blown out of the largest boilers, the boilers refilled without dumping the fire, and the locomotive made ready for service in thirty-five minutes. The amount of scale and mud taken from a boiler that has run for forty-five days with treated water will approximate about the same amount as one run for seven days with untreated water, with this difference, that quite a percentage of the stuff removed from the boiler using treated water consists of scale which has loosened up and come down and was made before treated water was used. Corrosion of tubes and plates has become a thing of the past. The claim or statement is not made that we are entirely free from scale in our boilers; this may be so when nothing but treated water is used.

Another feature is the economy found in keeping the boilers comparatively free from scale, resulting in better conditions of heat and a consequent increase in number of miles run per ton of coal, which during the year 1904 was increased 5.7 per cent., with an increased trainload of 6.5 per cent. The saving in coal alone would pay an interest of 5 per cent. on the total cost of the plants installed. The life of the fireboxes must be increased, absence of mud means absence of burned firebox sheets, and any man in close touch with the situation knows that more fireboxes are burned out than are worn out.

You must not think that you can put in an occasional plant here and there and continue the old methods of boiler-washing and get the benefits. If you do, you will be disappointed. Mixing impure water in a boiler with treated water is not a good thing to do, for unless you understand what has been done, the results will lead you to believe that water purification is a delusion and a snare. Neither must you believe your engines will all stop leaking when you have pure water. Other remedies must be applied to overcome bad firing, bad pumping, rapid contraction caused by hurried boiler-washing, running engines from the ash pit to engine-house with fire out and dampers open, and many other abuses that the locomotive is subjected to either by conditions that cannot be overcome or by careless and indifferent men handling them.

Much misdirected effort has been made in the way of using various boiler compounds made on the shotgun or patent medicine principle, but without any attention being paid to the local conditions, the quality or quantity of the water in which they were to be used. Unquestionably, the disappointing results have served to retard intelligent inquiry. Each year larger locomotives are being built with a corresponding increase of water consumption, and the evils from use of impure water must multiply.

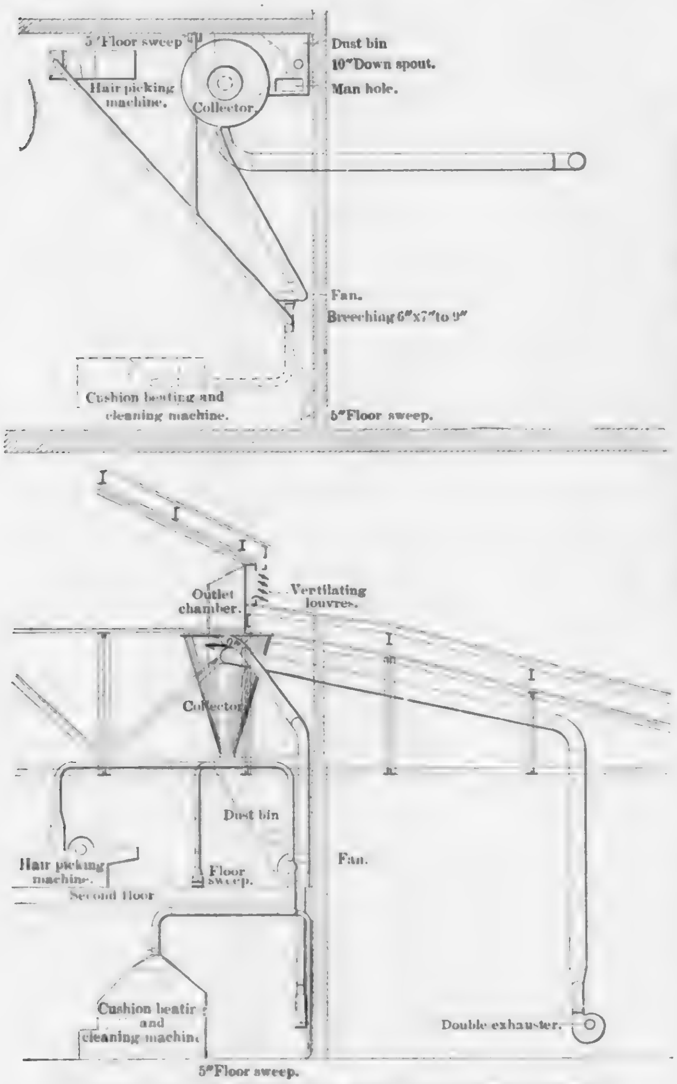
As an illustration of what can be done where nothing but treated water is used, will state that our power-house, containing water-tube boilers of 1,500-h.p. capacity, is using softened water, containing in its natural state 3.9 lbs. of scale-forming solids to each 1,000 gals.; each boiler evaporates on an average 1,000 gals. per hour. These boilers are examined once for each 35 days, and were they using untreated water would contain 3,200 lbs. of scale material at each examination; as it is, however, they are sometimes found to be entirely clean, and then again the lower tubes may have a light film of scale which can easily be washed off.

It is a matter that requires daily intelligent attention, and the results that have been obtained assure us that the opportunities for economies are such as to (if understood) convince any progressive railroad manager that, even though the first cost is large, the returns are so prompt and liberal as to make it unwise to attempt to do without it.

Why Steel Can Be Cut Faster Than Cast Iron.—With all the tool steels working on steel at high speeds the continual rubbing of the shaving on the upper surface of the tool wears more or less of a pit on the surface. At the same time, on the extreme point of the tool a small accumulation of portions of the material being cut gathers, being practically welded to the tool. Now, the position of the pit on the upper surface of the tool is situated further back from the cutting edge with a deep cut than with a light one. This is owing to the tenacity of the steel, and is not found to be the case in turning cast iron. The tenacity of the shaving and the action of the tool as a wedge cause the actual point of cleavage to be in advance of the extreme edge of the tool. The larger the chip the greater its strength is, and therefore the further back on the tool it slides, making a greater angle between the shaving and the work wherein the front of the tool is more or less clear. The tool splits off the shaving of material like an axe cleaving wood with the grain. After having once entered, the cutting edge of the axe is clear, while the thicker part of the axe, acting like a wedge, forces the wood apart. In my opinion, the action of the tool in cutting steel is similar, and with the larger cuts the greater part of the work is done well back on the tool, where there is a good body of steel. In a lighter cut the shaving wears a pit right up to the cutting edge, thereby weakening it, and causing it to break down sooner. With cast iron, owing to its brittleness, the action is different, and the work is practically all concentrated on the cutting edge. When the tool first penetrates a piece of iron is broken off for a little distance in advance of the tool; the roughness intervening is removed as the work revolves against the tool, the point of which again penetrates and breaks off a portion, and so the action continues.—*Mr. Arthur B. Corby, before the Salford Science Students' Association.*

PASSENGER CAR REPAIR SHOP.

The arrangement of the passenger car repair shop of the Lake Shore & Michigan Southern Railway at Collinwood is shown on the accompanying drawing. In this shop 80 ft. of the south end is partitioned off and sub-divided to accommodate three important departments, the tin and pipe shop, the brass finishing and lacquering department, and the upholstering department, including the cushion cleaning, dyeing and drying work.

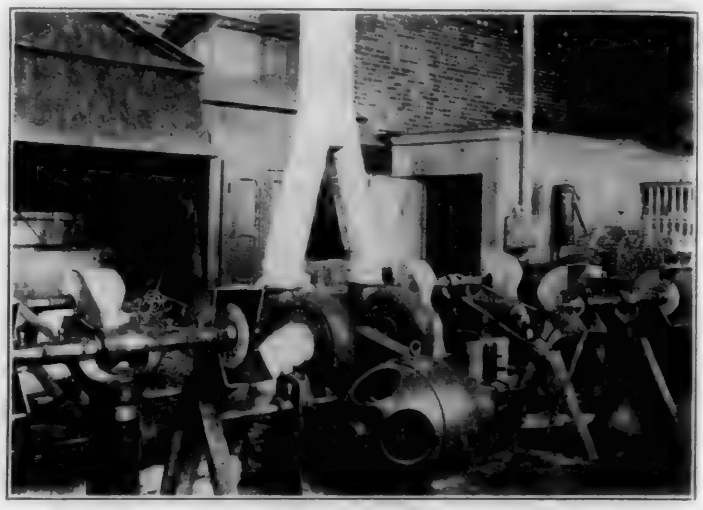


PIPING ARRANGEMENT FOR DUST COLLECTOR SYSTEM.

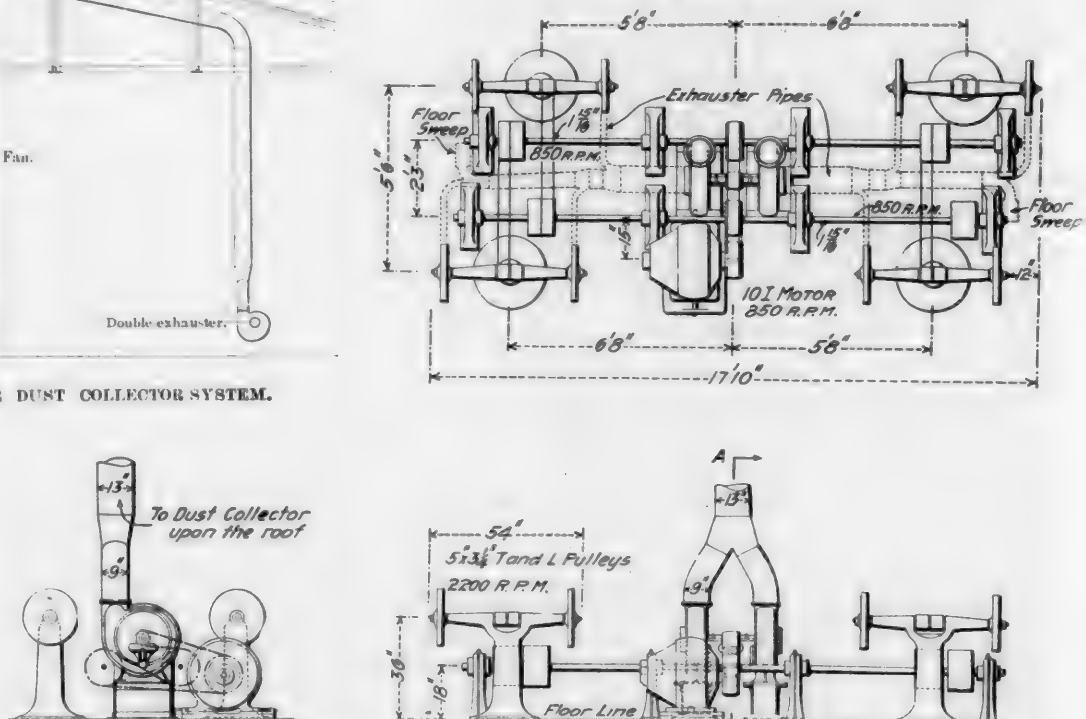
The arrangement of the buffing wheels in the brass finishing room is remarkable not only for its compactness and simplicity, but also for the convenience to the workmen. This is best shown in the detail view and the photograph of the finishing room, presented herewith. There are four two-wheel buffing stands, located 5½ ft. apart between centres of spindles. Between them are arranged the two driving shafts, which turn in opposite directions as is required; these shafts are carried in floor-stand bearings, 18 ins. above the floor. There are two exhausting blowers, used in this group for the purpose of removing the dust and lint from the buffs, which are located at the center of the group, between the two shafts and opposite the motor.

The driving motor, which is a 10-h.p. Crocker-Wheeler direct-current machine, operating at constant-speed of 850 revs. per min., is located in front of the group and drives the two shafts as well as the blower by an interesting arrangement of pulleys so as to use a single belt; this may be understood from the cross section view of the group at A-B. The belt passes over the blower pulley, then wraps back to the nearest shaft pulley, and from there to the further shaft pulley and back. In this way the purpose of the drive is fulfilled—the shafts are operated in opposite directions, and moreover the driven pulleys each have a much larger arc of belt contact than they could otherwise possibly have. This drive works very smoothly and satisfactorily.

The dust collecting system has proved a very efficient and helpful factor in the operation of this department. Each buff



THE BUFFING WHEEL GROUP AND DUST EXHAUSTER IN THE BRASS-FINISHING ROOM. LACQUER CLOSETS AND BAKING OVEN AT THE REAR.



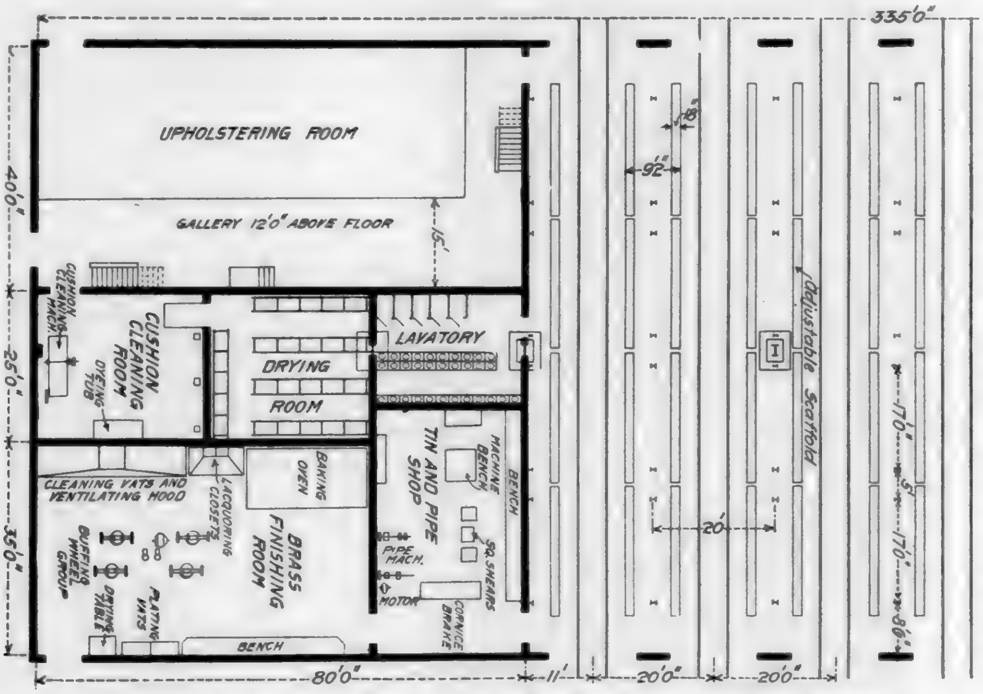
ARRANGEMENT OF BUFFING WHEEL AND EXHAUSTER APPARATUS, SHOWING METHOD OF DRIVING FROM A SINGLE MOTOR.

is constantly served while in operation by an exhaust suction, so that the obnoxious dust from buffing brass is constantly removed from the operator; this not only makes the work much more comfortable for the workmen, but also keeps the room clean at all times. The dust is delivered from the two exhausters up through the roof to a centrifugal dust collector, which also serves the cushion cleaning and hair picking machinery in the next room.

The photograph of the brass finishing equipment is also of

interest in that it shows at the rear the arrangement of ventilating hood over the cleaning and washing vats to carry off the fumes from the acids, etc. Next to this at the right may be seen the lacquering closets, which have special ventilation to protect the workmen from the disagreeable smell of lacquer as far as possible. Beyond in the corner of the room is the baking oven where the freshly lacquered pieces are baked thoroughly by a slow heat; the heat is supplied by steam coils around the walls and the walls are carefully insulated by a special asbestos sheet construction.

The west half of this portion of the passenger car repair shop is occupied by the upholstering department. This consists of a large main work room, 40 ft. by 80 ft., with a gallery extending around its north and east sides, in which the refitting and sewing work upon the cushions is done. Beyond this room to the east is the cleaning room, which contains a cushion whipping and cleaning machine and the apparatus for washing, as well as also dyeing, the cushions. The drying room adjoins this to the north. Above the cleaning room is the hair-picking room in which is located the machinery for picking and renovating the hair used for stuffing cushions.



DETAIL PLAN OF THE SOUTH END OF THE PASSENGER CAR REPAIR SHOP.

LOCOMOTIVE TEST COMMITTEE.—The advisory committee, representing various scientific and technical interests in the locomotive tests at the St. Louis Exposition, has completed its work and has expressed its appreciation of the action of the Pennsylvania Railroad for the testing plant and all it stands for and specially mentioning Messrs. J. J. Turner, T. N. Ely, F. D. Casanave, A. W. Gibbs, A. S. Vogt, E. D. Nelson and G. L. Wall for their support, co-operation and efficient assistance. This action on the part of the committee is appropriate and pleasing to all those who know the services which have been rendered to the railroad world through these tests.

PRODUCTION IMPROVEMENTS.—There is very little knowledge that can yield larger, immediate dividends than continuous and reliable information about details. Troublesome? Yes. Expensive? Also, yes. But by obtaining and utilizing this information so as to improve both machine and man output, our officials have been able to reduce times over 40 per cent., and to make actual savings anywhere from 35 per cent. to 100 per cent. on all current operations so controlled.—*Mr. Harrington Emerson, Western Railway Club.*

DIES AND FORMERS FOR BULLDOZERS.

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Dull or poorly ground tools restrict the output of a machine, waste power, turn out an inferior grade of work and shorten the life of the machine because of the greater amount of power required.

PASSENGER CAR REPAIR SHOP.

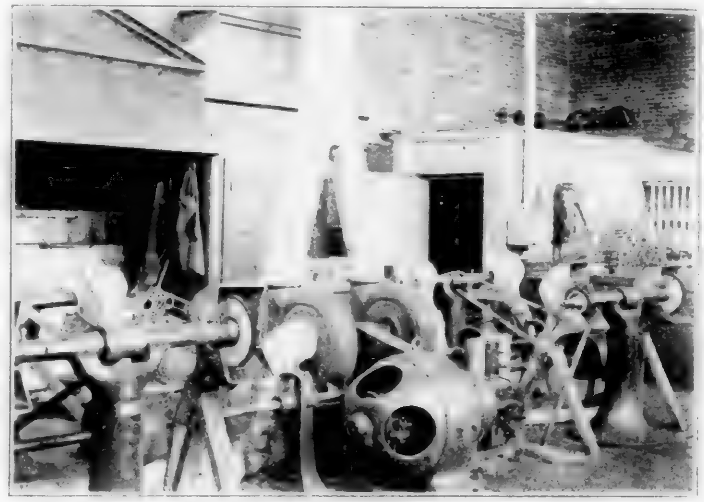
The arrangement of the passenger car repair shop of the Lake Shore & Michigan Southern Railway at Collinwood is shown on the accompanying drawing. In this shop 80 ft. of the south end is partitioned off and sub-divided to accommodate three important departments, the tin and pipe shop, the brass finishing and lacquering department, and the upholstering department, including the cushion cleaning, dyeing and drying work.

PIPING ARRANGEMENT FOR DUST COLLECTOR SYSTEM.

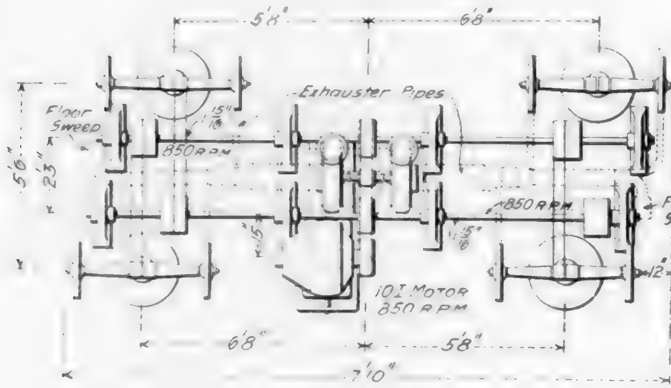
The arrangement of the buffing wheels in the brass finishing room is remarkable not only for its compactness and simplicity, but also for the convenience to the workmen. This is best shown in the detail view and the photograph of the finishing room, presented herewith. There are four two-wheel buffing stands, located 5½ ft. apart between centres of spindles. Between them are arranged the two driving shafts, which turn in opposite directions as is required; these shafts are carried in floor-stand bearings, 18 ins. above the floor. There are two exhausting blowers, used in this group for the purpose of removing the dust and lint from the buffs, which are located at the center of the group, between the two shafts and opposite the motor.

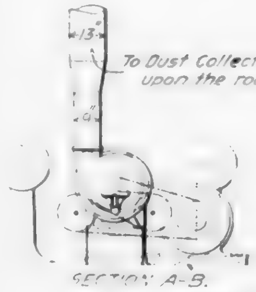
The driving motor, which is a 10-h.p. Crocker-Wheeler direct-current machine, operating at constant speed of 850 revs. per min., is located in front of the group and drives the two shafts as well as the blower by an interesting arrangement of pulleys so as to use a single belt; this may be understood from the cross section view of the group at A-B. The belt passes over the blower pulley, then wraps back to the nearest shaft pulley, and from there to the further shaft pulley and back. In this way the purpose of the drive is fulfilled—the shafts are operated in opposite directions, and moreover the driven pulleys each have a much larger arc of belt contact than they could otherwise possibly have. This drive works very smoothly and satisfactorily.

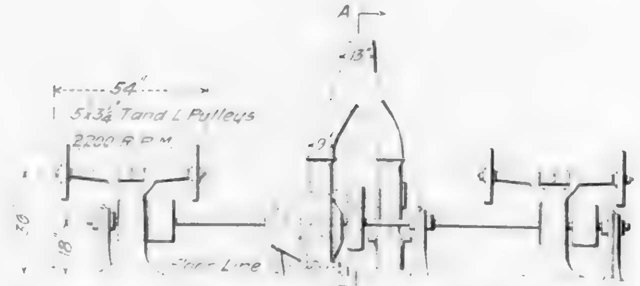
The dust collecting system has proved a very efficient and helpful factor in the operation of this department. Each buff



THE BUFFING WHEEL GROUP AND DUST EXHAUSTER IN THE BRASS FINISHING ROOM. LACQUER CLOSETS AND BAKING OVEN AT THE REAR.







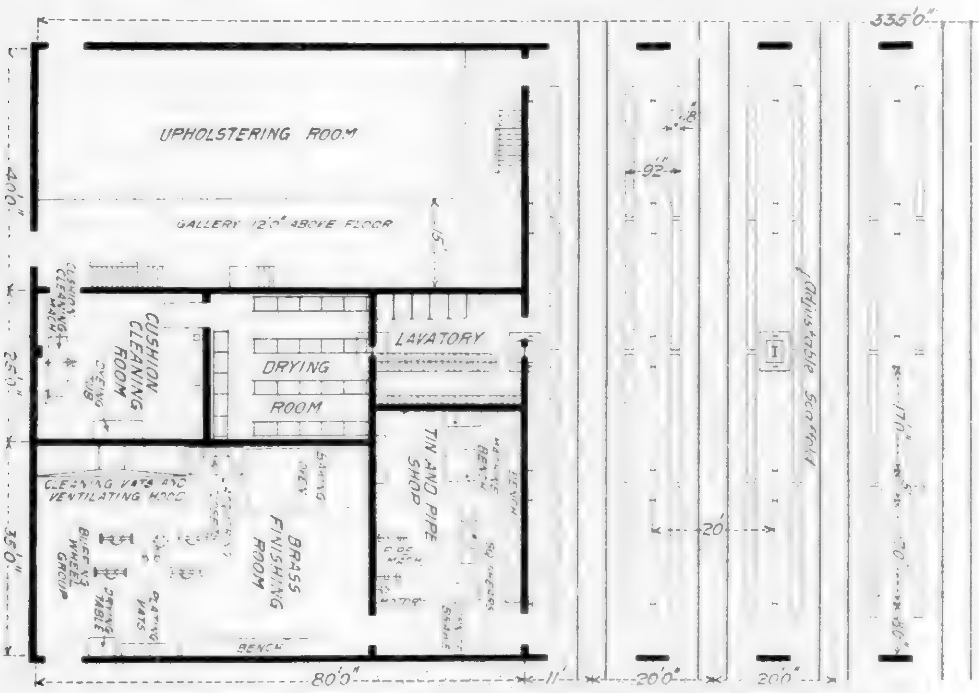
ARRANGEMENT OF BUFFING WHEEL AND EXHAUSTER APPARATUS, SHOWING METHOD OF DRIVING FROM A SINGLE MOTOR.

is constantly served while in operation by an exhaust suction, so that the obnoxious dust from buffing brass is constantly removed from the operator; this not only makes the work much more comfortable for the workmen, but also keeps the room clean at all times. The dust is delivered from the two exhausters up through the roof to a centrifugal dust collector, which also serves the cushion cleaning and hair picking machinery in the next room.

The photograph of the brass finishing equipment is also of

interest in that it shows at the rear the arrangement of ventilating hood over the cleaning and washing vats to carry off the fumes from the acids, etc. Next to this at the right may be seen the lacquering closets, which have special ventilation to protect the workmen from the disagreeable smell of lacquer as far as possible. Beyond in the corner of the room is the baking oven where the freshly lacquered pieces are baked thoroughly by a slow heat; the heat is supplied by steam coils around the walls and the walls are carefully insulated by a special asbestos sheet construction.

The west half of this portion of the passenger car repair shop is occupied by the upholstering department. This consists of a large main work room, 40 ft. by 80 ft., with a gallery extending around its north and east sides, in which the refitting and sewing work upon the cushions is done. Beyond this room to the east is the cleaning room, which contains a cushion whipping and cleaning machine and the apparatus for washing, as well as also dyeing, the cushions. The drying room adjoins this to the north. Above the cleaning room is the hair-picking room in which is located the machinery for picking and renovating the hair used for stuffing cushions.



DETAIL PLAN OF THE SOUTH END OF THE PASSENGER CAR REPAIR SHOP.

Locomotive Test Committee.—The advisory committee, representing various scientific and technical interests in the locomotive tests at the St. Louis Exposition, has completed its work and has expressed its appreciation of the action of the Pennsylvania Railroad for the testing plant and all it stands for and specially mentioning Messrs. J. J. Turner, T. N. Ely, F. D. Casanave, A. W. Gibbs, A. S. Vogt, E. D. Nelson and G. L. Wall for their support, co-operation and efficient assistance. This action on the part of the committee is appropriate and pleasing to all those who know the services which have been rendered to the railroad world through these tests.

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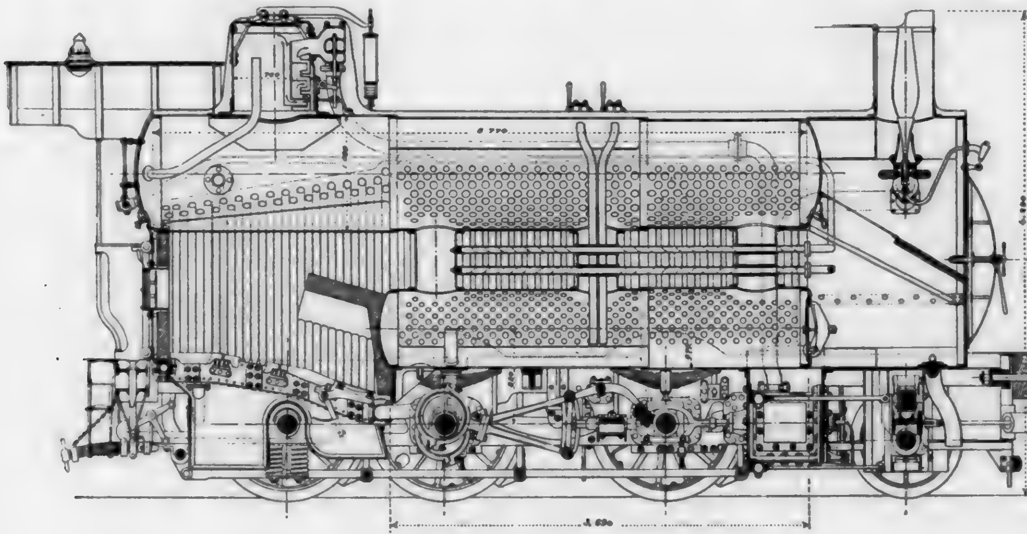
WATER TUBE LOCOMOTIVE BOILER.

PARIS, LYONS AND MEDITERRANEAN RAILWAY.

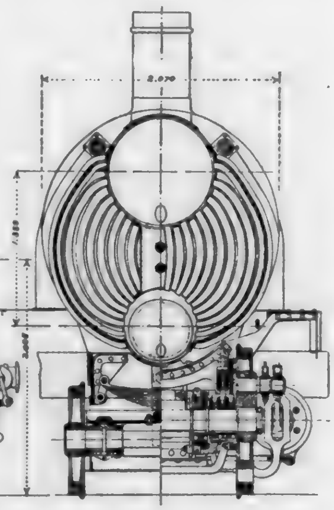
This boiler seems to be successful and it is worthy of record because of an increased interest in water tube boiler possibilities for locomotives. The design is by Mr. J. Robert of the Algerian system of the Paris, Lyons and Mediterranean Railway. There are two horizontal drums, the larger being over the smaller one. These provide water and steam space and they are connected by curved tubes 2.6 in. in diameter, expanded into both drums. Three thimbles connect the two drums as shown in the engraving. From the rear end of

In order to facilitate cleaning the water tubes, two blower pipes extend through the central space and pierce the two forward thimbles which connect the drums. These pipes have many apertures through which jets of steam are blown in inclined directions against the water tubes for the removal of soot and ashes. The valve for these pipes is located in the cab.

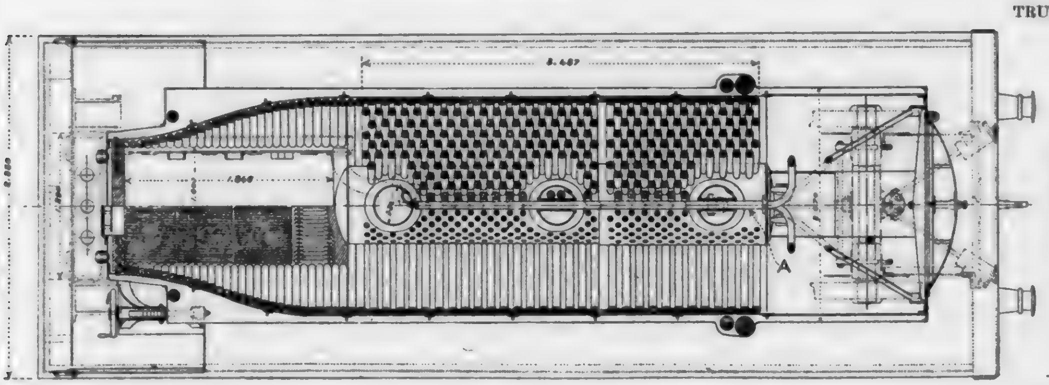
When first applied, in February, 1904, the boiler had copper tubes, but these have been replaced by steel. Experience has shown little trouble with mud in the drums, but scale formed in the tubes has required removal by brushes, hammers and tube cleaners on flexible shafts. This boiler is said to steam freely and raise steam rapidly.



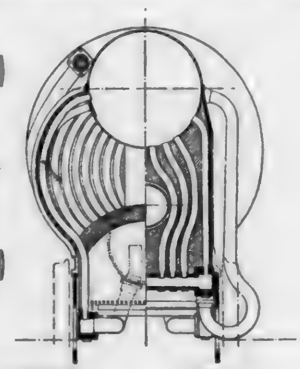
LONGITUDINAL SECTION.



SECTION AT TRUCK AND BOILER. SECTION AT DRIVING AXLE



SECTIONAL PLAN.



SECTION FRONT OF FIREBOX. SECTION BEHIND FIREBOX.

WATER TUBE LOCOMOTIVE BOILER—PARIS, LYONS & MEDITERRANEAN RAILWAY.

the lower drum circulating pipes connect with headers below the level of the grates. These headers are connected with the upper drum by a series of tubes placed close together and forming the inside shell of the firebox, the tubes being covered with a thin steel plate as an outside envelope.

According to a descriptive article by Mr. Sausoll in the *Revue Generale des Chemins de Fer*, from which this description is taken, this boiler was applied to a 2-8-0 freight locomotive, one of a class of which the following table gives the leading characteristics:

	Plain Boiler.	Water Tube.
Cost of boiler itself	$5,000	$4,250
Heating surface, firebox	105 sq. ft.	166 sq. ft.
Heating surface, tubes	1,146 sq. ft.	1,043 sq. ft.
Heating surface, drums	......	74 sq. ft.
Heating surface, total	1,251 sq. ft.	1,283 sq. ft.
Weight of boiler, full	18.5 tons.	19.3 tons.
Weight of boiler, empty	15 tons.	13.5 tons.
Grate area	19.8 sq. ft.	20.8 sq. ft.
Tubes, number	208	616
Tubes, outside diameter	2 ins.	2.6 ins.
Tubes, length	12 ft.	....
Capacity of boiler	211 cu. ft.	300 cu. ft.
Volume of water at working level	166 cu. ft.	248.9 cu. ft.

1906 MASTER CAR BUILDERS' AND MASTER MECHANICS' CONVENTION.

Mr. L. B. Sherman, secretary of the Railway Supply Men announces that the location of the next convention of the Master Car Builders' and Master Mechanics' Associations will be determined by the following gentlemen: Mr. A. E. Mitchell, superintendent of motive power of the Lehigh Valley R. R., S. Bethlehem, Pa.; Mr. G. W. Wildin, mechanical superintendent Erie Railroad, Meadville, Pa., and Mr. F. K. Shults, representing the Supply Mens' Association, whose address is 95 Liberty street, New York. Mr. Shults is chairman of this committee and all communications should be addressed to him in care of the Camel Company, 95 Liberty Street, New York.

ELECTRIC COMMERCIAL WAGONS.—*The Automobile Builder*, of Cleveland, estimates that the number of electric commercial wagons now in actual service in this country can be conservatively placed at four thousand.

OPERATION OF THE McKEES ROCKS SHOPS' POWER PLANT.

A few points in connection with the compact and efficient power plant for the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad may be of interest. This plant is thoroughly up to date in almost every respect. It embodies a great many of the best features in power plant design. The building is 77 x 100 x 50 ft. high from the basement floor. Most of the pumps are in the basement. The main floor is divided by a brick partition wall into engine room and boiler room. The boilers are six Babcock & Wilcox 264 h.p. each, nominal rating. They are, however, worked much above this rating. A load of 1,800 b.h.p. has been carried for several hours on four boilers. It was calculated that five boilers would at any time be sufficient to take care of the load, leaving one for spare. In connection with these boilers, I may say that we had a great amount of trouble at first from burning out tubes, 56 tubes requiring to be replaced in three months. When the water softening plant was installed and in good working order the trouble ceased, and now the tubes remain almost as clean as the day they were installed. The coal and ashes are handled by machinery, the coal is dumped from hopper cars through a grating to a hopper beneath, whence it is hoisted by endless chain or conveyor to top of building; it is there dumped on a horizontal conveyor, which deposits it at points desired in the storage bins, when it flows by gravity to stoker hopper. The ashes are handled from the basement by the same machinery and are dumped into a storage bin directly over the track, thence into hopper cars beneath. Coal capacity is 200 tons; ash capacity, 2,000 cu. ft. The engines installed are four 14 x 24 x 14 Westinghouse compound engines, 280 r.p.m., about 250 h.p. Generators are of the direct connected Westinghouse, 150 k.w. capacity, 240 volts. The switchboard is an 18 panel board, consisting of four generator panels, one load panel, five incandescent light and constant speed motor panels, three arc light panels and five variable speed motor panels. There are fifteen pumps, which cover every purpose and are of various capacities, from a 50-gal. test pressure pump to a 1,000-gal. cold water supply pump. Five of the pumps are motor driven centrifugal or turbine pumps.

The two air compressors are each capable of compressing 1,000 cu. ft. of free air per minute to 100 lbs. pressure. There are also what are termed balancers or motor generators to split the 240-volt circuit into two 120-volt circuits for the arc lighting and six voltages from 40 to 240 for the variable speed motors.

The power plant takes care of the heating of the whole system of buildings, some of the buildings being half a mile from the power house. The heating is performed by circulating hot water through large heating coils in the various buildings, from which the heat is extracted by the air forced over them by fans. The temperature in all the buildings is controlled in the power house by raising or lowering the temperature of the water, which can be done at will. The water is heated in the power house in large heaters by means of exhaust steam supplemented by live steam, and is circulated through the system by two centrifugal pumps. It is expected that the heating load in 10-deg. weather will, when all the buildings are up, be about 40,000,000 b.t.u. per hour, 40 per cent. of this being taken care of by the exhaust steam. The steam pressure carried is 150 lbs., voltage 250 volts d.c., water pressure, general service, 80 lbs.; fire service, 100 lbs.; hot water supply, 125 lbs.; test pressure, anything up to 400 lbs. About 4,000,000 gals. of water are used per week, and as 95 per cent. of this is double pumped, the pumps handle about 8,000,000 gals. a week.

The force at the power house consists of a superintendent who has charge of the men on three tricks, each trick consisting of one engineer, one oiler and one fireman; in addition, there are during the daytime two extra helpers. This is a very small force of men, and the good results can only be accomplished on account of the large number of labor-saving devices installed and the care and forethought expended on the original design. The plant is not yet worked to the limit, as several new buildings have yet to go up, but from present appearances it would seem that it will accomplish what it was designed for. The plant is sometimes criticised on account of the small electric units used, but the load varies very greatly. On summer nights one generator is sufficient to carry the load, while on dark days in winter all four generators are in service.

In proportioning the cost everything is based pro rata on the actual steam consumption, the steam consumption in most cases being based on result of tests. An extract from the 1904 yearly report is as follows:

PITTSBURGH & LAKE ERIE RAILROAD COMPANY, McKEES ROCKS POWER PLANT.

	Total.	Monthly Average.
Steam Pressure, Pounds		148.3
Coal Consumption:		
Cars, total	265	22.08
Pounds, total	22,724,400	1,893,700
Pounds per hour		2,592.1
Ashes, cars loaded	42	3.5*
Water Evaporated:		
Gallons, total	20,910,000	1,742,500
Pounds per hour		19,373.2
Pounds per hour per lbs. of coal:		
Actual		7.475
From and at 212 deg.		8.662
Boiler h.-p. developed		645.8

*Ashes were 13 per cent. by weight of the coal.

EXPENSES.

			Per Cent.
Wages	$10,274.95	$856.25	50.27
Supplies	1,861.48	155.11	9.11
Machine Repairs	1,483.54	123.63	7.26
Coal	6,817.62	568.14	33.36
Total	$20,437.54	$1,703.13	100.00

GENERAL DISTRIBUTION.

Heating	$3,208.01	$267.34	17.00
Compressed Air	5,464.66	455.39	26.31
Lighting	2,255.20	187.93	11.10
Pumping	4,779.69	398.31	22.78
Machine Tools, etc.	3,602.66	300.22	17.32
Locomotive Filling	1,127.32	93.94	5.49
Total	$20,437.54	$1,703.13	100.00

RATES

Cost in cents, per	Maintenance.	*Total.
B. H. P. Hour, developed	0.367	0.752
K. W. Hour	0.628	1.286
H. P. Hour, electric	0.469	.962
1,000 Cu. Ft. free air, comp.	1.695	3.474

*Based on cost of plant of $165,000, 5 per cent. interest and 8 per cent. depreciation.

[EDITOR'S NOTE.—A detailed description of the power plant will be found in the May, 1904, issue of this journal, page 169. The above article is taken from a paper read before the Engineers' Society of Western Pennsylvania by Mr. G. M. Campbell, electrical engineer of the Pittsburgh & Lake Erie Railroad.]

In passing through a large railroad shop one day during the recent hot spell the writer noticed a unique advantage which was being taken of an individual motor-driven machine tool. The motor was mounted above the headstock of a Jones & Lamson turret lathe, and the machine operator had fastened a small fan to the end of the armature shaft, so that a cool breeze was directed upon him while the machine was in operation.

VACATIONS.—"The summer vacation is one of the most useful of business customs," declared an employer. "By means of vacations the employer gets a line on his men. For instance, Mr. A is away two weeks and his work is done by young B, who accomplishes more and makes suggestions that are worth following. That means that A's department is going to turn out more work from that time on. Then perhaps old C takes a month and leaves his assistant in charge. If things go to pieces it means that C needs a new assistant or that C is selfish about developing a possible successor. In any case we have learned something mighty interesting and useful."—*N. Y. Sun.*

FIG. 2—TRAVELING TROLLEY RUNNING OFF THE TRANSFER BRIDGE ON TO ONE OF THE SPUR TRACKS.

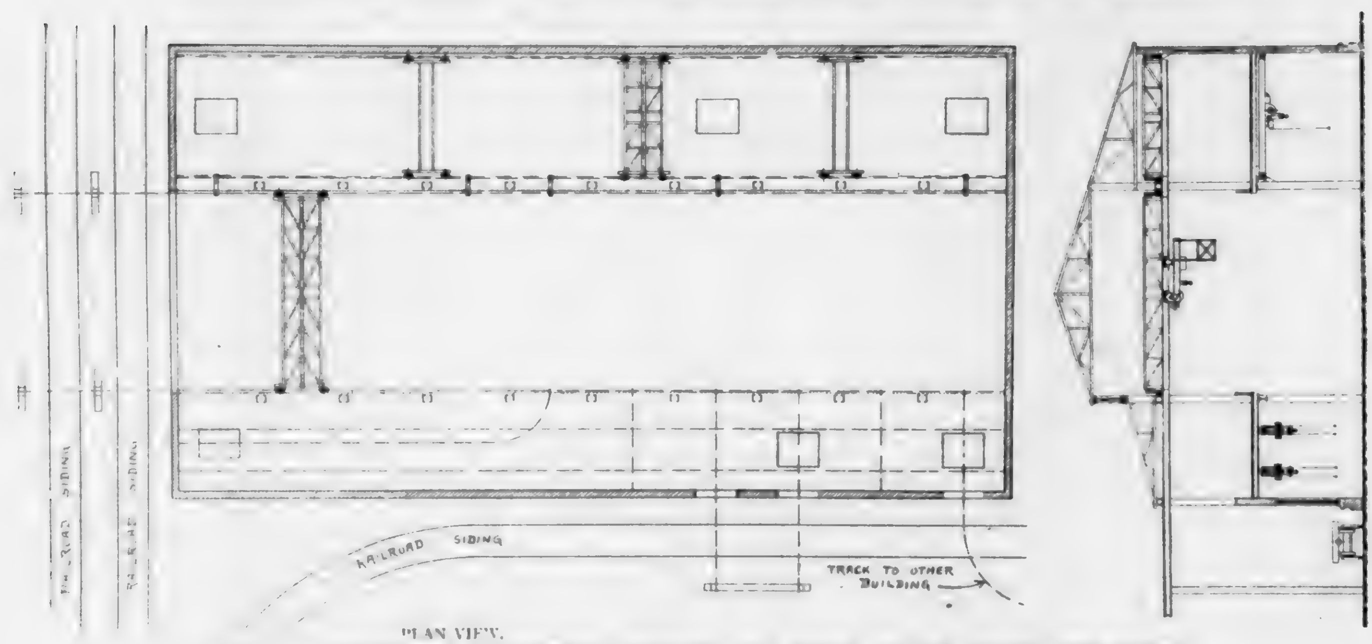


FIG. 1—ARRANGEMENT OF TRAVELING TROLLEYS AND HOISTS AT THE RAMAPO IRON WORKS.

ELECTRIC TRAVELING HOISTS.

An inexpensive system of traveling cranes for handling loads from 1½ to 5 tons, and which is admirably adapted for use in railroad storehouses and scrap yards, has been installed at the Ramapo Iron Works, Niagara Falls, N. Y. The trolleys and hoists run on the lower flanges of a single I beam, and it is thus possible to install this arrangement in places where it would be impossible to arrange for regular crane runways, and it is very much less expensive. The traveling trolleys may be run off the transfer bridge on to the single I beam tracks, which may be arranged in almost an endless variety of ways, making it possible to carry the load to any point in an extensive plant. As an illustration, the diagram in Fig. 1 shows some of the combinations which are used at the Ramapo Iron Works. The transfer bridge operates over the middle bay of the shop, running out at one end over the two railroad sidings. The trolley on this traveling crane may be run off on to another crane in the gallery to the right of the main bay in the cross sectional elevation, or it may be run on to the spur tracks in the gallery to the left. One of these spur tracks runs to another building; two of them extend out over the rail-

road siding; two others extend over the gallery and one curves around and runs lengthwise of the gallery.

Fig. 2 shows the traveling trolley as it is about to leave the transfer crane to run onto one of the spur tracks. The cage for the operator is attached to the trolley, so that the operator is always with the load. In transferring the trolley it is only necessary to move the transfer table in line with any one of the spur tracks. An independent motor drive through a train of gearing is used for traversing the trolley along the track and only two conductor wires are required for each spur track. The trolley may be provided with swivel trucks to allow it to run around curves of from 12 to 20 ft. radius. When the transfer bridge is used it is operated by a separate motor, controlled from the operator's cage on the trolley. A set of stops is provided for the transfer bridge and spur tracks, so as to prevent the trolley from running off the track.

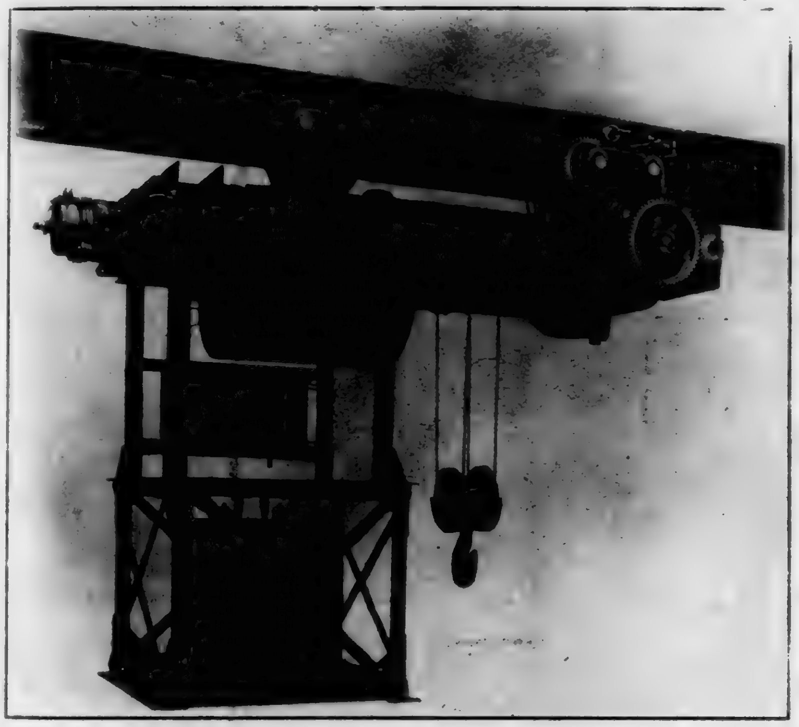


FIG. 3—NILES ELECTRIC TRAVELING TROLLEY.

If the nature of the plant is such that the traveling crane, which, in this instance, acts as a transfer table, is not required, it would be very easy to arrange a series of the I-beam tracks, which could be connected by switches, and it would thus be possible to arrange to transfer loads from one part of a plant to the other. Such a system could readily be extended from time to time to meet the growing demands, and could readily be adopted for almost any purpose. These traveling hoists and trolleys are made by the Niles-Bement-Pond Company, 111 Broadway, New York.

CONDENSING VERSUS NON-CONDENSING PLANTS.—It is generally assumed that a low water rate condensing plant is more economical than a non-condensing one where the rate is higher, but such is not always the case. If all the heat in the exhaust steam can be made use of, then relatively inefficient but low cost engines would, when interest and depreciation as well as the coal pile are considered, be the cheapest to install and maintain. If steam from the boiler is eventually discarded as water and at the same time the feed water enters the boiler at or near 212 degs., what more could be desired or obtained? I have in mind a non-condensing plant of 2,000 b.h.p., which in winter uses every ounce of exhaust steam and in summer a very large percentage of it. That plant is working very economically, though the engines and pumps installed have a high water rate.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

STARTING A STEAM TURBINE.

In his recent paper before the American Society of Mechanical Engineers Mr. A. S. Mann described the starting of turbines in a power station as follows:

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air pump are started by the oiler. These movements take place simultaneously. The force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after performing it looks to see that there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine.

The turbine throttle is opened as fast as an 8-in. steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit, but if nothing unusual occurs in the pipe line sentiment does not spare the turbine.

One electrician attends to the switchboard and telephone. As soon as the machine approaches speed the synchronizing system is cut in and the main switches are got ready. One and one-half minutes will do all the work here outlined, including the considerable time taken in mustering the crew from various parts of the building.

Manipulating an engine regulator so that it shall be at a precise speed and at an exact phase relationship from some other machine, not more than 1-1500th part of a second removed from it, is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in 2½ minutes, including full load on the turbine, which starts from a standstill.

This performance has been gone through a great many times, and our record book shows that out of 43 such calls 10 starts were made in 2½ minutes, 18 in 3 minutes and 15 in 3½ minutes. We have taken the time in a number of instances when all the auxiliaries have been in motion and it only remained to start the turbine and phase it in on the line; the only valves to open in such cases are the throttle and one small oil valve. The two quickest starts have been made in 45 seconds and 70 seconds, respectively, including phasing-in. Others range between 1 minute 10 seconds and 1½ minutes. These two quickest starts were made on a turbine which had stood for 24 hours with the throttle valve shut tight, though there was a slight leakage past the seat. After the throttle valve is off its seat it is not more than 30 seconds before the turbine is up to speed. A cross compound reciprocating engine of the four-valve type, 2,250 h.p. capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the seventy seconds required for the similar turbine operation.

A reciprocating engine, which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated, can be brought up to speed, say 75 turns, in 2½ minutes. This can be compared with the 30 seconds necessary for bringing the turbine up under the same conditions; that is, about one-fifth the time necessary for bringing up the engine.

If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, 15 minutes is called a rapid

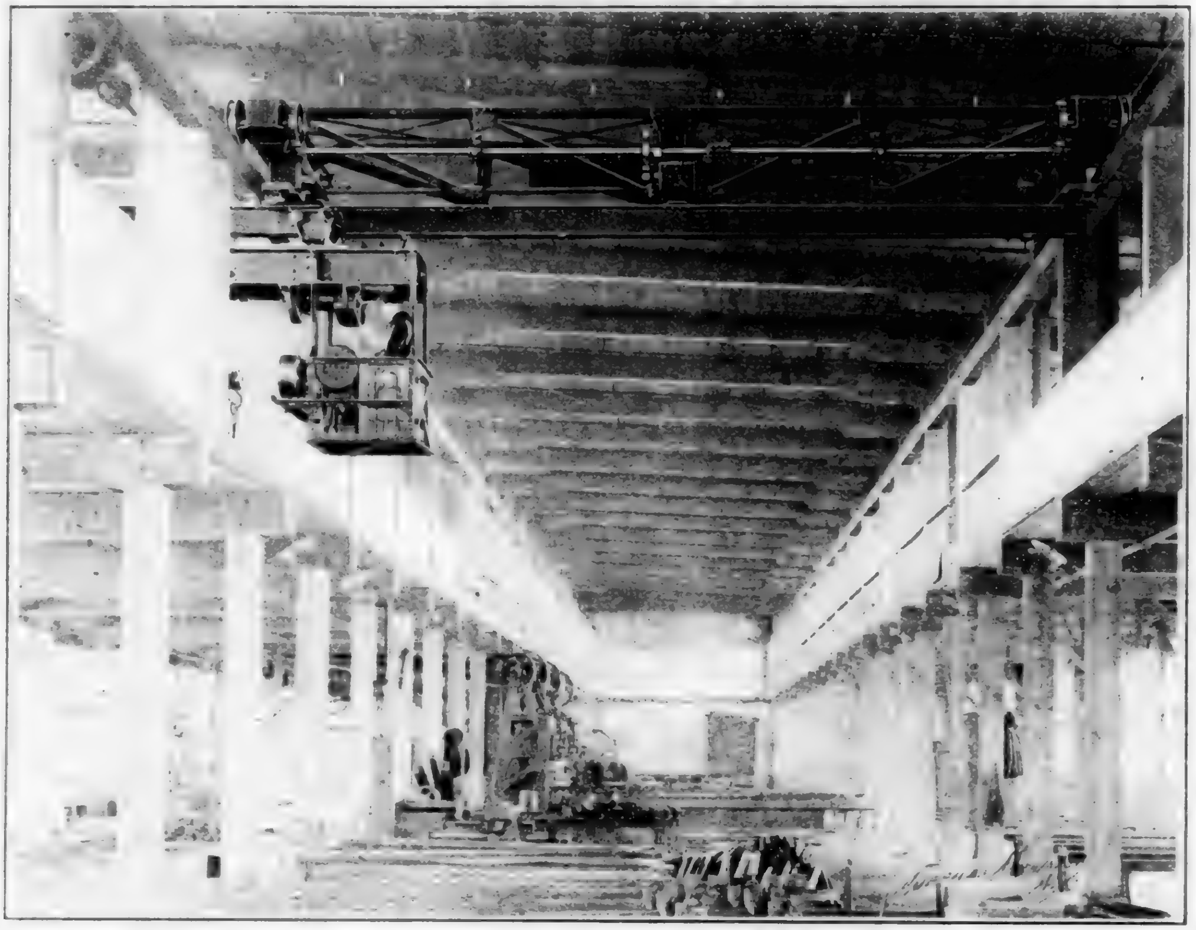


FIG. 2—TRAVELING TROLLEY RUNNING OFF THE TRANSFER BRIDGE ON TO ONE OF THE SPUR TRACKS.

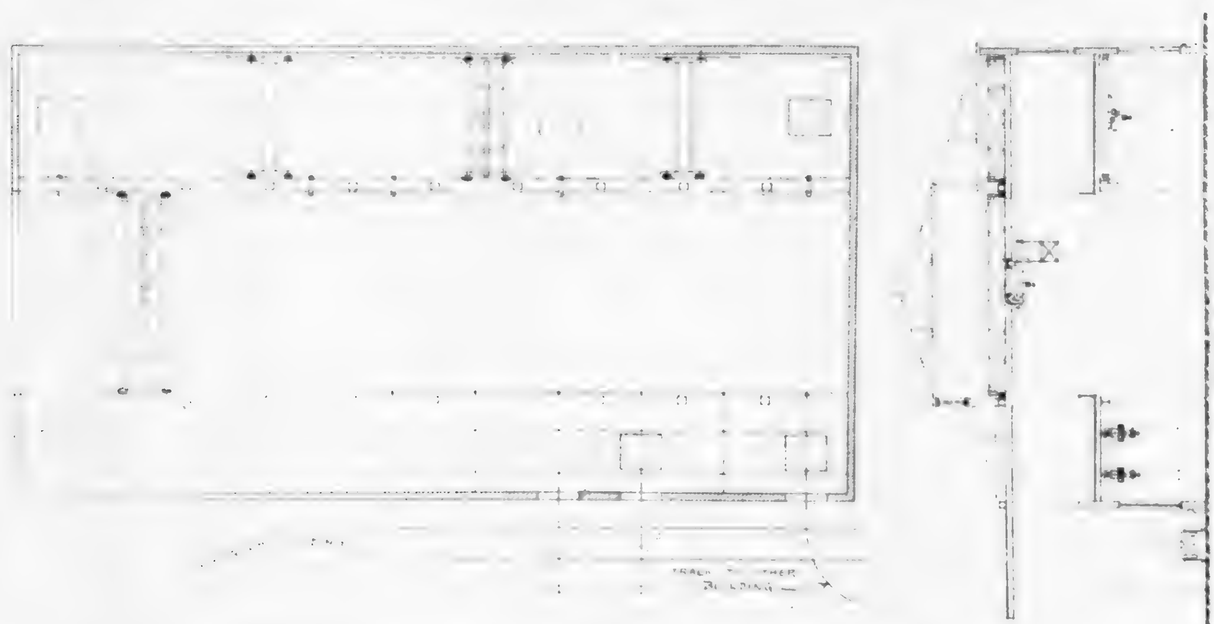


FIG. 1—ARRANGEMENT OF TRAVELING TROLLEYS AND HOISTS AT THE RAMAPO IRON WORKS.

ELECTRIC TRAVELING HOISTS.

An inexpensive system of traveling cranes for handling loads from $1\frac{1}{2}$ to 5 tons, and which is admirably adapted for use in railroad storehouses and scrap yards, has been installed at the Ramapo Iron Works, Niagara Falls, N. Y. The trolleys and hoists run on the lower flanges of a single I beam, and it is thus possible to install this arrangement in places where it would be impossible to arrange for regular crane runways, and it is very much less expensive. The traveling trolleys may be run off the transfer bridge on to the single I beam tracks, which may be arranged in almost an endless variety of ways, making it possible to carry the load to any point in an extensive plant. As an illustration, the diagram in Fig. 1 shows some of the combinations which are used at the Ramapo Iron Works. The transfer bridge operates over the middle bay of the shop, running out at one end over the two railroad sidings. The trolley on this traveling crane may be run off on to another crane in the gallery to the right of the main bay in the cross sectional elevation, or it may be run on to the spur tracks in the gallery to the left. One of these spur tracks runs to another building; two of them extend out over the rail-

…l siding; two others extend over the gallery and one curves …nd and runs lengthwise of the gallery.

…ig. 2 shows the traveling trolley as it is about to leave the …sfer crane to run onto one of the spur tracks. The cage …the operator is attached to the trolley, so that the operator …lways with the load. In transferring the trolley it is only …essary to move the transfer table in line with any one of … spur tracks. An independent motor drive through a train …gearing is used for traversing the trolley along the track …l only two conductor wires are required for each spur track. … trolley may be provided with swivel trucks to allow it to … around curves of from 12 to 20 ft. radius. When the …nsfer bridge is used it is operated by a separate motor, con…lled from the operator's cage on the trolley. A set of stops …provided for the transfer bridge and spur tracks, so as to …vent the trolley from running off the track.

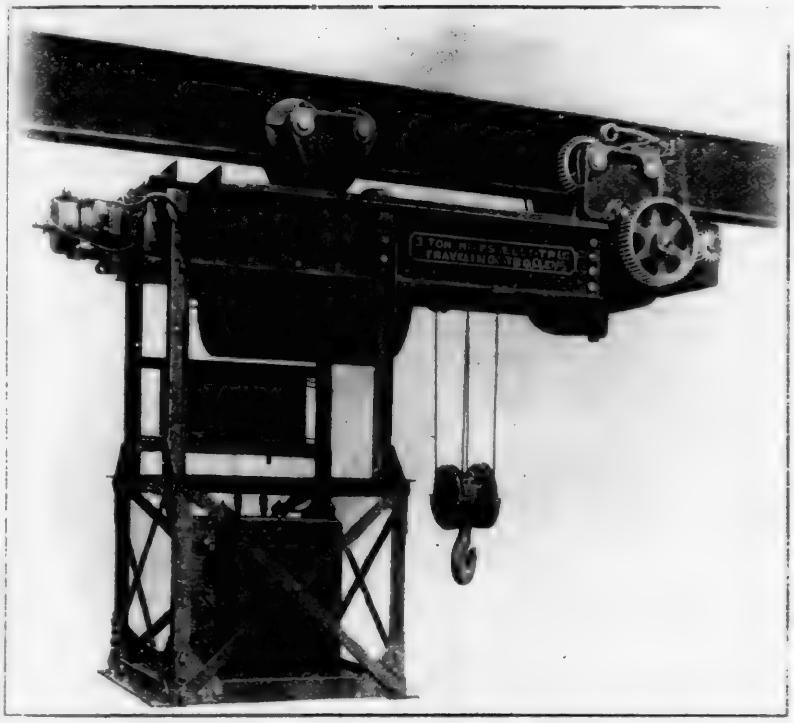


FIG. 3—NILES ELECTRIC TRAVELING TROLLEY.

If the nature of the plant is such that the traveling crane, …hich, in this instance, acts as a transfer table, is not required, …would be very easy to arrange a series of the I-beam tracks, …hich could be connected by switches, and it would thus be …ossible to arrange to transfer loads from one part of a plant … the other. Such a system could readily be extended from …ime to time to meet the growing demands, and could readily …e adopted for almost any purpose. These traveling hoists and …olleys are made by the Niles-Bement-Pond Company, 111 …roadway, New York.

CONDENSING VERSUS NON-CONDENSING PLANTS.—It is generally …ssumed that a low water rate condensing plant is more eco…omical than a non-condensing one where the rate is higher, …ut such is not always the case. If all the heat in the ex…haust steam can be made use of, then relatively inefficient …nt low cost engines would, when interest and depreciation …s well as the coal pile are considered, be the cheapest to in…tall and maintain. If steam from the boiler is eventually …iscarded as water and at the same time the feed water enters …he boiler at or near 212 degs., what more could be desired …r obtained? I have in mind a non-condensing plant of 2,000 …h.p., which in winter uses every ounce of exhaust steam …nd in summer a very large percentage of it. That plant is …working very economically, though the engines and pumps installed have a high water rate.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

STARTING A STEAM TURBINE.

In his recent paper before the American Society of Mechanical Engineers Mr. A. S. Mann described the starting of turbines in a power station as follows:

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air pump are started by the oiler. These movements take place simultaneously. The force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after performing it looks to see that there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine.

The turbine throttle is opened as fast as an 8-in. steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit, but if nothing unusual occurs in the pipe line sentiment does not spare the turbine.

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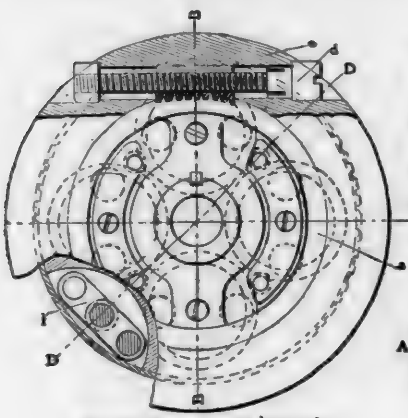
If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, 15 minutes is called a rapid

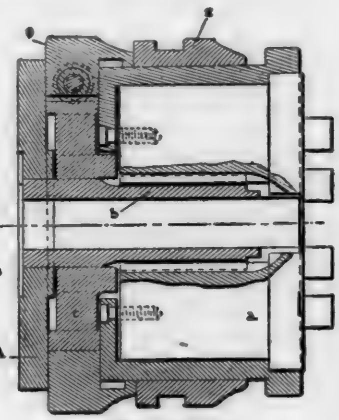
start. Starts have been made under such conditions in 12 minutes. When we start a cold turbine we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed, and she will be at speed in 2½ minutes, dividing the engine's time by more than four.

LANDIS BOLT CUTTER HEAD AND CHASERS.

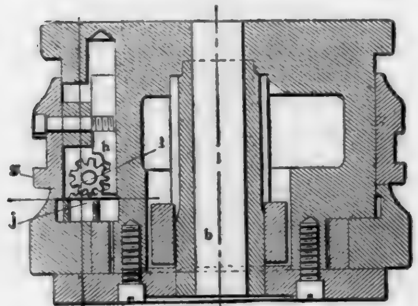
The Landis bolt cutter head and chasers, shown in detail in the accompanying illustrations, have several notable features which makes it possible to increase the capacity of a bolt cutter, at the same time reducing the cost of maintenance of the dies. The die is composed of four chasers, as shown in Fig. 1, which are made from flat pieces of steel with the threads which form the teeth milled their entire length. The chasers may be sharpened by a simple grinding operation, and no annealing, hobbing and retempering is necessary. They may be repeatedly sharpened until reduced to a very short length. The chasers are beveled at the front edge, and the throat thus preserves a uniform shape after grinding, and



Rear View with Flange A Removed



Section on Line B-B



Section on Line D-D

DETAIL CONSTRUCTION OF LANDIS DIE HEAD.

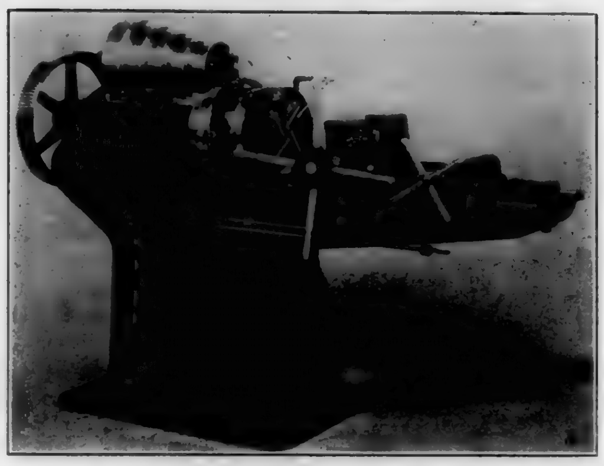
it is at all times possible to cut close to the head of the bolts. Each chaser is held in a grooved block, and these blocks are carried by four oscillating spindles, which are geared together in the head, and are made to operate simultaneously to open and close the die and to adjust it to the proper size. A screw with a circumferentially grooved head holds the chaser in place by engaging the threads, clamping it rigidly. An adjusting screw at the other end of the block forces the chaser downward until the piece becomes too small to hold. In grinding the chasers the holder is set on a gauge, which may be used in connection with any ordinary cutter grinder.

The cutting is at all times done by the front teeth, while the back teeth do no cutting, but take a bearing on the work a little back of the face of the chasers, thus forming a permanent hardened lead nut, whose bearing surface is renewed each time the chaser is ground. The clearance in the die admits of the highest possible cutting speed. After grinding, the chasers are set to the proper position in the holders by means of a gauge. They are set on lines tangent to the bolt and at an angle to agree with the pitch of the thread. This die head may readily be attached to bolt cutters other than the Landis. The head has no wearing surfaces exposed to chips and scale, and the bearings are so arranged that any wear which may take place will not affect the efficiency of the die.

The construction of the die head is shown in Fig. 4. The four oscillating spindles, *a*, each have two pins upon which the chaser blocks are slipped. At *b* is a central pinion bored out to allow the work to pass through and engaging with a short series of teeth formed on each spindle *a*. Near the rear end of the pinion is fastened a disk, *c*, which is engaged at its periphery by a rack adjusted by screw *d* to set the die to

1

2



1. BOLT CUTTER HEAD SHOWING ONE HOLDER AND CHASER REMOVED. 2. CHASERS AND HOLDERS. 3. DIE HEAD APPLIED TO LANDIS BOLT CUTTER.

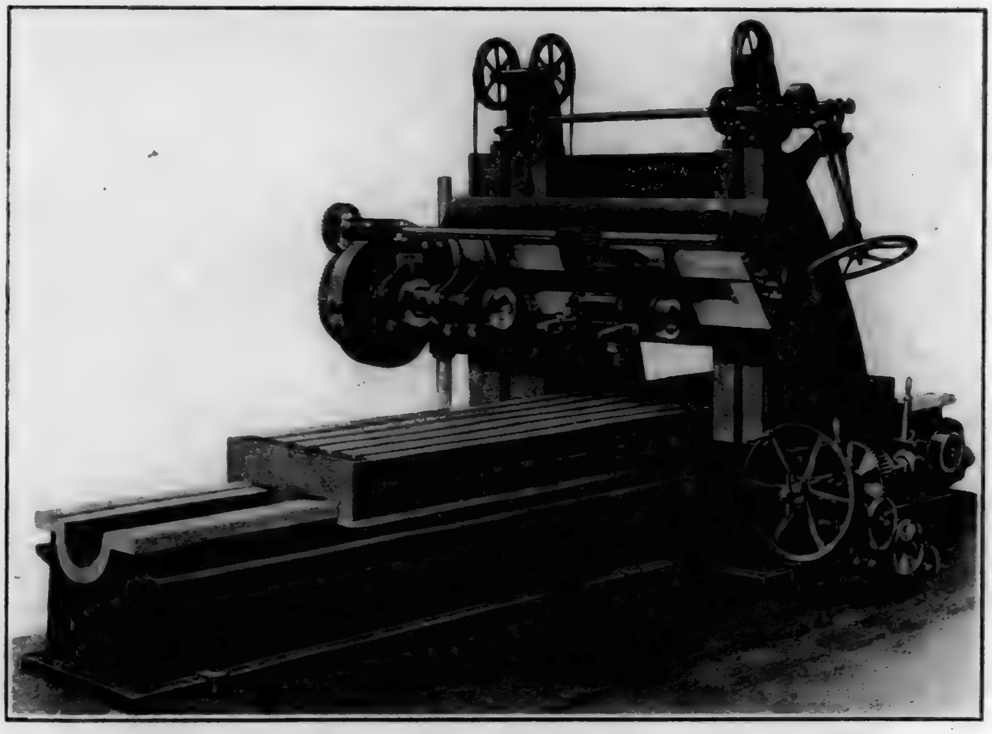
proper size. The rack is seated in a ring, *e*, encircling the head; and this ring, through toggle links, *f* (connected at one end to *e* and at the other to the body of the device), is given a limited oscillating movement to operate pinion, *b*, and so open or close the chasers. The toggle is operated by ring, *g*, which is moved back and forth by lever and yoke, shown in Fig. 3, this ring being attached to a rack, *h*, meshing with a pinion, *i*, which also meshes with rack teeth formed on the head of toggle connection, *j*. With ring *g* thrown back the toggle pin is lifted to the position shown, the links are thrown out straight as at *f*, and the chasers are positively locked in cutting position. When ring *g* is slid forward again the toggle draws the chasers open. The pins upon which the toggle

links are mounted are so arranged that through openings in the rear plate the pin in ring *e* may be slid into a seat in the head proper, and the other pin drawn into a seat in the ring, thus reversing the action of the ring and giving the chaser block trunnions the right movement for left-hand chasers.

A chuck for holding nut taps is composed of four holders, which may be substituted in place of the chaser holders. This chuck may be opened and closed the same as the one for the die. This device is made by the Landis Machine Company, Waynesboro, Pa.

PLANER TYPE MILLING MACHINE WITH AUXILIARY VERTICAL SPINDLE.

The planer type milling machine, illustrated herewith, is adapted for heavy work, such as the milling of locomotive side rods, rod brasses, driving boxes, shoes and wedges, and cross-heads, and is equipped with an auxiliary vertical spindle, which in no way interferes with the horizontal spindle, and may be used to advantage on such work as milling key-ways and for finishing the front section of locomotive frames. The cross rail is counterweighted and has an inclined face, and this design, in connection with the extra heavy and rigid uprights, overcomes to a very great extent the tendency to chatter, and also of dropping in when running from a wide to a narrow section. The table is operated by means of a spiral pinion and rack, and has a wide range of feeds, variable through friction discs, and also has a power quick traverse in either direction.



PLANER TYPE MILLING MACHINE WITH AUXILIARY VERTICAL SPINDLE.

The carriage is 36 ins. wide and 12 ft. long, and the uprights will admit work 40 ins. wide. The maximum distance from the center of the horizontal spindle to the table is 30 ins. The horizontal spindle is 6 ins. in diameter, and has an in-and-out adjustment of 6 ins. on the cross rail for convenience in setting the cutters. The auxiliary vertical spindle is designed and constructed as a part of the outboard bearing of the horizontal spindle which carries the cutters. The horizontal spindle which drives the vertical spindle is 3 ins. in diameter. The vertical spindle has an independent vertical adjustment of 2 ins. with a micrometer and is adjustable across the rail the full width of the table, and where desired will be furnished with an automatic cross feed. This machine is made by the Newton Machine Tool Works, Philadelphia, Pa.

THE SHEARING STRENGTH OF RIVETS.

The following report on the shearing strength of rivets was presented at the Master Steam Boiler Makers' Convention at Chicago, and the conclusions of the committee are such as to warrant a careful study of the report by those interested in this subject:

On beginning our tests a number of pieces were prepared according to rules and formulas approved by mechanical engineers and which are in use at the present time by many, if not all, of the prominent builders. While a number of the joints showed an efficiency above that rated for them, we found that invariably they showed a weakness at the edges of the plate, tearing out from the edge of hole to the edge of plate, so that from these pieces it was impossible to determine the actual shearing strength of the rivet. We at first concluded we had made an error in preparing the plates. However, on checking up our work we found conditions as follows: A standard rule in practice, accepted generally by the builders, is as follows: For distance from center of rivet hole to edge of plate, take D × 1.5, which, in our case, would be diameter of hole, 13-16 in. × 1.5 = 1.21 ins. This we increased slightly, making the lap 1¼ ins., and to further insure the shearing of the rivet we used ½-in. plate with ¾-in. rivets in 13-16-in. holes, and out of eight pieces tested with the rivets in double shear (four with iron and four with steel rivets) each one of them fractured at the edge of the plate.

We next prepared four pieces with rivets in double shear, two having iron and two steel rivets, one hand and one machine riveted, and instead of using the constant 1.5 we used 2. On testing the first piece, using iron rivets in double shear, the result was: Shearing strength of one rivet, 42,240 lbs.; shearing strength per sq. in., 81,481 lbs., hole elongated and end of plate distorted, 0.16-in. The next test resulted as follows: Iron rivet in double shear — shearing strength of one rivet, 40,920 lbs.; shearing strength per sq. in., 78,934 lbs.; hole elongated and end of plate distorted, about the same as first test.

We next tested a piece prepared the same as the two previous tests, except with steel rivets in double shear, which resulted as follows: Shearing strength of one rivet, 46,575 lbs.; shearing strength per sq. in., 89,843 lbs. In this case the hole was elongated and end of plate distorted 0.34 in. The next test with steel rivet in double shear resulted as follows: Shearing strength of one rivet, 43,805 lbs.; shearing strength per sq. in., 84,500 lbs.; hole elongated and end of plate distorted, 0.29 in.

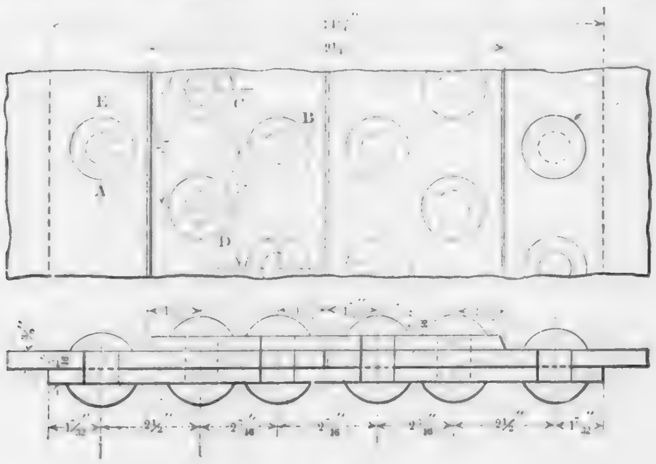
The rivets tested in single shear resulted as follows: 1. Test iron rivet—shearing strength of one rivet, 22,190 lbs.; shearing strength per sq. in., 42,824 lbs. 2. Test iron rivet—shearing strength of one rivet, 20,840 lbs.; shearing strength per sq. in., 39,409 lbs. 3. Test steel rivet—shearing strength of one rivet, 25,840 lbs.; shearing strength per sq. in., 49,845 lbs. 4. Test steel rivet—shearing strength of one rivet, 25,840 lbs.; shearing strength per sq. in., 49,845 lbs. It will be noticed that the steel rivets in single shear showed exactly the same results.

Following is a table showing the kind of rivets, diameter and area of hole, shearing strength of one rivet, shearing strength per sq. in. and increase in percentage for double over

single shear. From this it will be noted that the increase for double over single shear averages considerably higher in iron rivets than it does in steel rivets; also that the increase is greater for machine driven rivets than for hand driven, this being attributed to the frictional resistance of the plates, which is not so effective in the hand work:

No. of test.	Kind.	Shear.	Diameter. Inch.	Area. Inch.	One rivet. Pounds.	Per square inch. Pounds.	Increase double over single. Per cent.	
1	Iron	Single	13-16	0 5184	22,190	42,824	...	Hand driven.
2	Iron	Double	13-16	0.5184	42,240	81,481	90	
3	Iron	Single	13-16	0.5184	20,430	39,409	...	Machine driven.
4	Iron	Double	13-16	0.5184	40,920	78,934	104	
5	Steel	Single	13-16	0.5184	25,840	49,845	...	Machine driven.
6	Steel	Double	13-16	0.5184	46,575	89,843	80	
7	Steel	Single	13-16	0.5184	25,840	49,845	...	Hand driven.
8	Steel	Double	13-16	0.5184	43,805	84,500	69	

We next prepared a triple riveted butt strap joint, using ⅜-in. plates with ¾-in. rivets (iron) in 13-16-in. drilled holes,



TRIPLE RIVETED BUTT STRAP JOINT.

as shown in the illustration herewith. This joint has a rated efficiency of 87.5 per cent. Using a section of 6½-in. wide plate, ⅜-in. thick, steel of 58,500 lbs. test strength, the strength of the solid plate should be 0.375 × 6.5 × 58,500, which equals 142,593 lbs.; 87.5 per cent. of this would be 115,145 lbs. By actual test this joint developed a strength of 115,120 lbs., or only 25 lbs. less than the calculated strength. Now, assuming that each rivet in this joint would sustain as great a load as in test No. 2 in the table, the shearing strength of the rivets in the section tested would be 42,240 lbs. × 3 (number of rivets in double shear) plus 22,190 lbs. (one rivet in single shear), or 148,910 lbs., or 22 per cent. stronger than the ultimate strength of the section tested. Next taking the net section at A, on the illustration, we have 6½ ins., or 104-16 — 13-16 = 91-16, which, divided by 104, the original or solid plate, gives 87.5, or the rated efficiency of the joint. However, our test showed the net section not to be the weakest point, but the fracture occurred first at B, tearing out from the hole to the edge of the plate at the first row, the same as in the first tests, and next shearing off rivets C, D and E. Now, as neither the ultimate strength of the net section nor the shearing strength of the rivets was actually reached when rupture occurred, it will be evident to all that this joint can be made considerably stronger by adding to the distance from the center of the hole to the edge of the plate, or, in other words, using 2 as a constant instead of 1.5 in calculations for rivets in double shear, as we found necessary to do in our tests previously described to ascertain the shearing strength of the rivets.

The shearing strength of rivets we find to be about as follows:

For riveted plates:	Pounds.
Iron rivets, single shear, average per square inch	40,000
Iron rivets, double shear, average per square inch	78,000
Steel rivets, single shear, average per square inch	49,000
Steel rivets, double shear, average per square inch	84,000

In addition we wish to invite your attention to the following points of interest:

1. The noticeably greater increase for iron rivets in double shear over their single shearing strength, as compared to steel rivets in double shear over their single shearing strength.

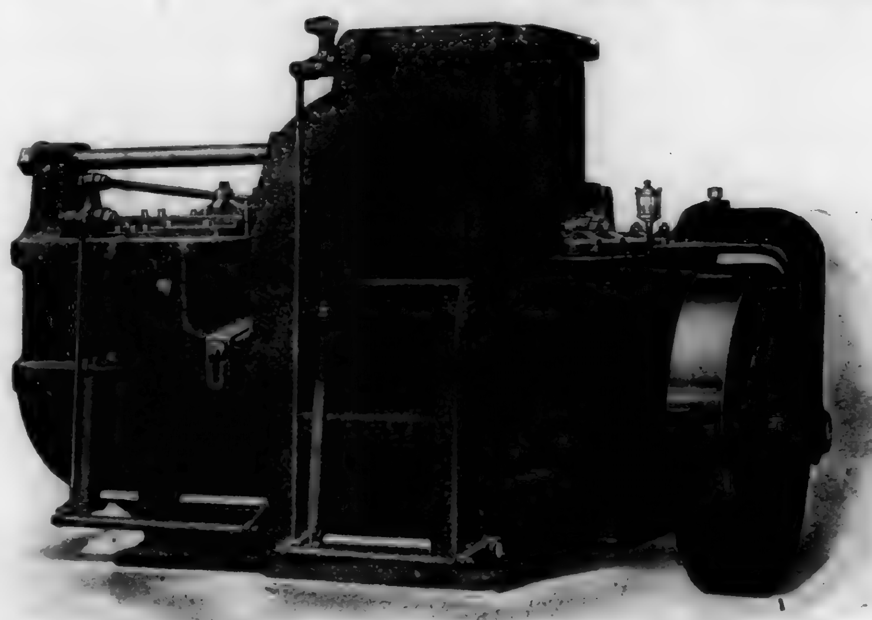
2. The greater increase for machine driven rivets in double shear over hand driven rivets; hand driven not to be hammered after getting cool.

3. The apparent necessity for deciding on a new constant in place of 1.5 for calculating the distance from center of holes to edge of plate for rivets in double shear at first row of holes.

In closing the committee wishes to extend its thanks to O. K. Harlan, assistant mechanical engineer, Delaware, Lackawanna & Western Railroad, and J. G. Platt, engineer of tests, Erie Railroad, for the assistance rendered in making the above tests.

UNIVERSAL FORGING MACHINE.

The Ajax universal forging machine, illustrated herewith, marks a new departure in forging machinery, as by its use forgings can be made at a considerably lower cost than formerly, due to the saving of heats and handling, and many intricate forgings can readily be made which it has been impossible to make on other forging machines. It retains all the features of the well-known Ajax heading, upsetting and forging machine and in addition has a powerful vertical press which may be used for forging, bending and trimming. This press has a vertical movement of from 3 to 5 ins., according to the size of the machine. A screw adjustment to the stroke of the head, readily accessible from all parts of the machine, enables the operator, when setting the dies, to bring them to the exact point desired.

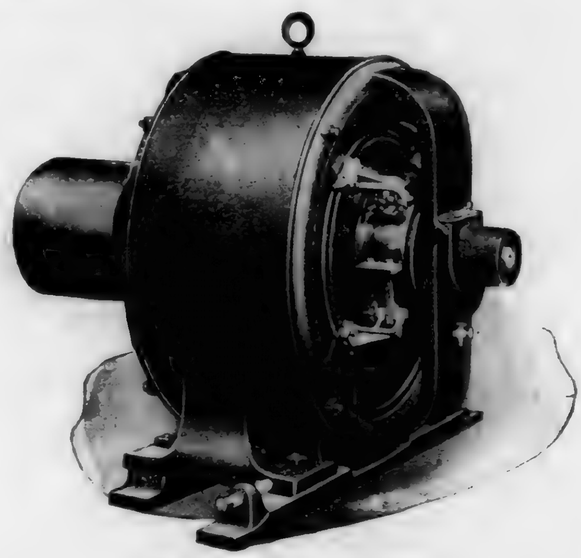


UNIVERSAL FORGING MACHINE—AJAX MANUFACTURING COMPANY.

The vertical movement of the head is obtained by heavy links, connected at the lower end with levers, on which are eccentric hubs which give the head the desired throw or stroke. These levers in turn are connected to a slide, placed

horizontally and actuated by an eccentric shaft in the back end of the machine. This mechanism is entirely separate and independent of that which operates the forging machine, although both are in the one bed. The forging press is brought into operation by the operator depressing the pedal on the right of the machine. This allows the lock, between the eccentric shaft and header slide, to drop into place. The operator can give one or more blows as desired. On taking the foot off the pedal the lock is released automatically and the forging press comes to a stop with the dies wide open. The locking device is an exact reproduction of the well-known Ajax lock, so successfully used on the Ajax heading, upsetting and forging machine.

The design of the bed is of box form, cast solid in one piece and made of a special mixture of strong, close-grained iron and of ample strength to withstand the excessive stresses incident to the operation of this class of machinery. These machines are built in seven sizes, known as A, B, C, D, E, F and G. The weight of the machines varies from 18,000 lbs. for the A size, to 180,000 lbs. for the G size. They are built by the Ajax Manufacturing Company, of Cleveland, Ohio, and are the invention of Mr. J. R. Blakeslee, Jr., general manager of the company.



20-H.P. STEEL FRAME MOTOR.

FRAME SHOWING ARMATURE IN POSITION.

STEEL FRAME MULTIPOLAR MOTORS.

The new steel frame motors made by the Triumph Electric Company, of Cincinnati, are notable for their light weight, high efficiency, good wearing qualities, accessibility of all parts, and their ability to stand heavy overloads and sudden fluctuations of load. The frame is made of close-grained steel, and its compact form and comparatively light weight greatly simplifies the problem where it is desired to mount the motor directly upon a machine tool. A special flexible idler, which increases the belt surface on the pulley and overcomes the slackness of the belt, makes it possible to use a belt drive with very close centers. The brackets are bolted to the frame, but may readily be removed if necessary. The construction is such that the motor may be mounted on the floor, wall or ceiling. The poles are of steel, and equipped with a special design of laminated tip or shoe, which adds considerably to the efficiency of the machine. The bearings are self-oiling and self-aligning. An oil guard on the armature and an improved method of carrying the brush yoke on the crown, instead of upon the pedestal, prevents the oil from getting into the armature, commutator or brush rigging, and thus causing short circuits.

The armature is of the iron clad, laminated core, tooth type, and is thoroughly insulated. The armature coils are form wound, and each consists of a continuous length of copper, with no joint except where connected to the commutator. The commutator bars are of hard-drawn copper, of extra depth, and are mounted upon a cast steel shell, so constructed that they cannot move and the commutator cannot get out of true. The field coils may be either shunt, series or compound wound, according to requirements. During construction and after being placed in the machine each coil is tested with 2,000 volts alternating current. The brush holders are of simple design, and are constructed with a view to the sparkless operation of the brushes, freedom from noise and minimum heating and wearing of the commutator. An interesting application of one of these motors to a traverse grinder, made by the Cincinnati Shaper Company, is illustrated on another page of this issue.

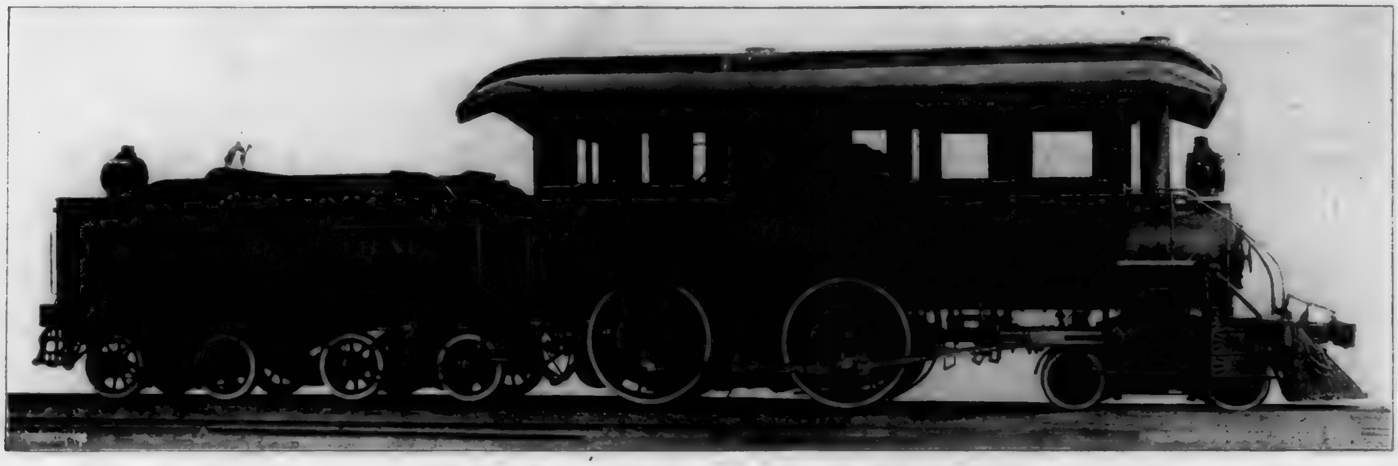
Wm. Sellers as a Designer of Machinery.—William Sellers had certain well-defined ideas. Beauty of line and grace of form were insisted on, and he early adopted, if he did not invent, the dull lead tint now known as "machine gray," which has now almost entirely supplanted the reds and greens and blacks of the early builders. Fitness for the purpose intended, as he saw it, was the keynote, and he had as much horror of unnecessary weight as he had of any other defect in proportion. In construction nothing suited him but the best. He was never deterred by consideration of cost if he saw a way of improving in design or construction. Absolute honesty of purpose was his dominant characteristic, and he would tolerate no deviation from the standard of workmanship, no matter how tempting might be the occasion. There was no thought of patching defects in workmanship or material. Nothing was "good enough" unless it was perfect. Jealous of his reputation, he set a high standard and followed it undeviatingly. He had to a wonderful degree the courage of conviction and would follow out his own conclusions without hesitation in the face of adverse opinion. In fact, opinions had very little weight with him in professional matters, but he would always listen to reasons, and if the reasons appealed to him he would abandon preconceived convictions readily and without apparent regret. He used to say that he had no "pride of invention," and would readily give up an idea on which he had long labored if convinced that something else offered was better.—*Journal of the Franklin Institute.*

Removing Splinters.—When a splinter has been driven into the hand it can be extracted by steam. Fill a wide-mouthed bottle nearly full of hot water, place the injured part over the mouth and press it slightly. The action thus produced will draw the flesh down, and in a minute or two the steam will extract the splinter, also the inflammation—*National Magazine.*

INSPECTION LOCOMOTIVE.

New York Central Lines.

The American Locomotive Company has completed at its Schenectady works an inspection locomotive for the New York Central lines. This locomotive was designed specially for this particular service, and has a very low boiler, with a high dome located over the firebox. The following list gives the chief characteristics of the locomotive, and the photograph shows its exterior appearance. With a tractive power of 14,800 lbs., this locomotive will be able to haul one or two business cars, which extends its field of usefulness beyond carrying an inspection party.



INSPECTION LOCOMOTIVE—NEW YORK CENTRAL LINES.

INSPECTION LOCOMOTIVE.

Fuel	Bituminous coal.
Tractive power	14,800 lbs.
Weight in working order	99,500 lbs.
Weight on drivers	66,500 lbs.
Weight of engine and tender in working order	182,700 lbs.
Wheel base, driving	8 ft.
Wheel base, total	22 ft. 8 ins.
Wheel base, engine and tender	46 ft. 2½ ins.
Cylinders, kind	Simple.
Cylinder diameter and stroke	15 by 24 ins.
Driving wheels, diameter over tires	62 ins.
Style of boiler	Wagon top crown bar.
Working pressure	200 lbs.
Outside diameter of first ring	46 ins.
Firebox, length and width	66 by 34 ins.
Tubes, number and outside diameter	158 2-in.
Tubes, gauge and length	11. 11 ft. 7ins.
Heating surface, tubes	951.38 sq. ft.
Heating surface, firebox	93.37 sq. ft.
Heating surface, total	1,044.75 sq. ft.
Grate area	15.72 sq. ft.
Water capacity	3,500 gals.
Coal capacity	6 tons.

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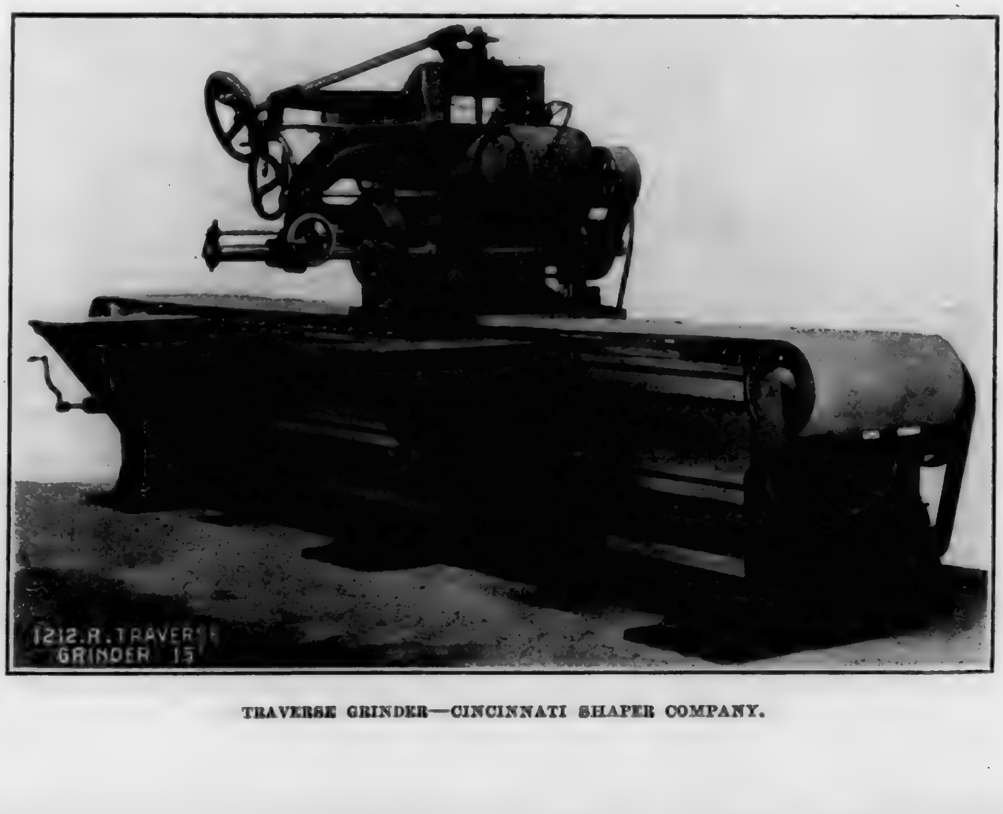
TRAVERSE GRINDER.

The illustration shows a convenient and substantial traverse grinder, which was designed specially for grinding manganese cast steel centers of railroad frogs and crossings, locomotive cross-head guides, finishing the butt ends of connecting rods, and is also adapted for such work as grinding the ways between the V's on lathe beds. The bed is cast in a box form with floor supports at the middle and the ends. It is braced internally by cross girts, and may be made in varying lengths, the one shown in the illustration being 15 ft. long, which permits a longitudinal travel of 12 ft. to the saddle which carries the grinding wheel. The saddle is traversed at the rate of 15 ft. per minute by means of a rack and pinion driven by a 2-h.p. motor, and is automatically reversed at each end of the stroke. A lever is provided for reversing the saddle by hand when necessary. The stroke may be adjusted to any length up to the limit of the machine.

The grinding wheel is driven by a 5-h.p. Triumph Electric Company motor, and has a horizontal movement in the direction of its axis of 15 ins. and a vertical movement of 11½ ins. The horizontal movement is controlled by the hand wheel attached to the bracket which supports the grinding wheel, and the vertical movement by the hand wheel on the end of the shaft, which is set at an angle. The third hand-wheel is for moving the saddle by hand. The motor is adjustable on the saddle, so that when necessary the belt driving the grinding wheel shaft may be tightened.



TRAVERSE GRINDER—CINCINNATI SHAPER COMPANY.

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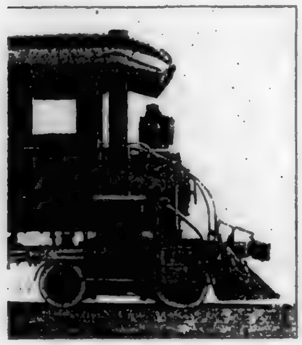

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MANUFACTURING PLANT OF THE B. F. STURTEVANT COMPANY.

These new works at Hyde Park, Mass., will accommodate about 2,000 workmen, the aggregate floor area of the finished buildings being over nine acres. The plant consists of a four-story office building, 45 by 125 ft.; a three-story building 80 by 500 ft. devoted to the manufacture of blowers, heaters and galvanized iron work; a building 80 by 250 ft. of the same height, on the first floor of which all engines will be tested, stored and shipped, while the other floors will be uti-

MACHINE SHOP SHOWING GOOD LIGHT SECURED BY SAW-TOOTH ROOF CONSTRUCTION.

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The entire plant is electrically driven and lighted at 220 volts from a central powerhouse, containing at present one 100 kw. and one 250 kw. Sturtevant generating set; the power plant engines run condensing; the exhaust steam derived from engines under test upon the plate in the testing building is utilized for heating, supplementary live steam being admitted at reduced pressure as may be required. Waste exhaust is discharged through a Sturtevant exhaust head. The boilers are equipped with a Sturtevant fuel economizer for heating the feed water. The powerhouse is placed sufficiently far from the ends of the buildings to permit of ample extension of each, and near enough to the water supply to reduce to a minimum the expense of conveying condensing and other water. Steam, electricity and compressed air are transmitted to the individual buildings through a concrete tunnel and a supplementary system of covered trenches.

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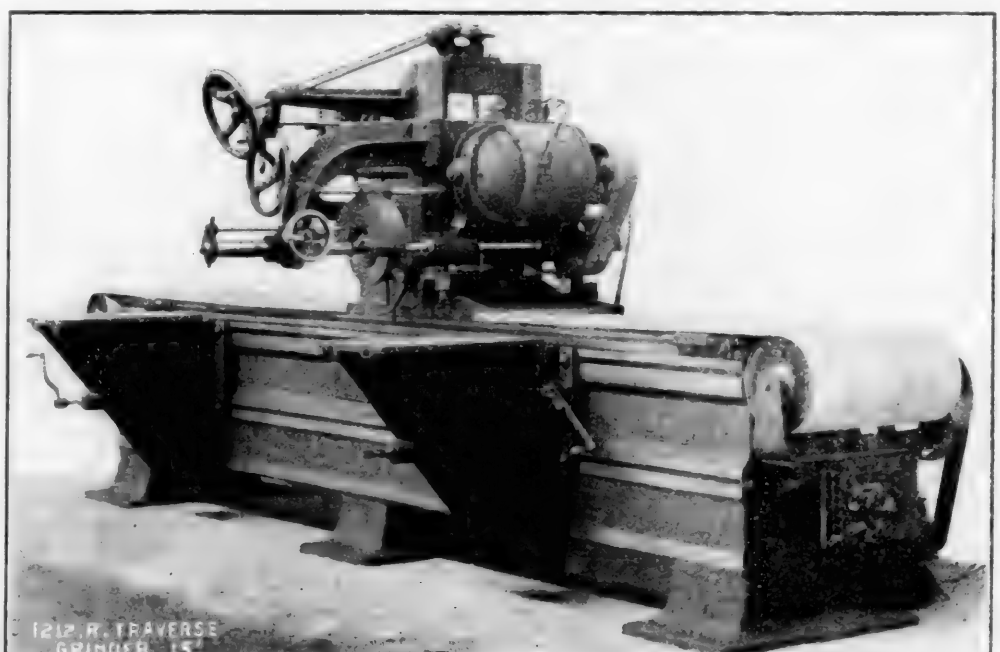

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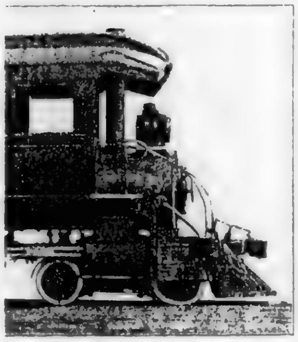

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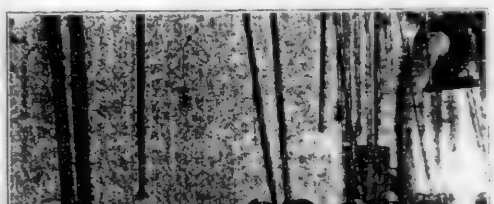


GRINDING MACHINES AND STURTEVANT EXHAUST FAN, HOODS AND PIPING.

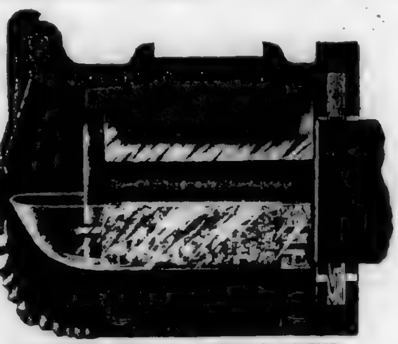
motors. Twenty horse-power motors suspended overhead are so located as to drive the small tools in groups of suitable size through individual lengths of line shaft. The smithshop is equipped with a full outfit of Sturtevant forges with blower for blast and exhaust fan for removing smoke. A detail description of the foundry and pattern shops will be found on page 431 of the November, 1903, issue of this journal.

The standard first floor height in the main buildings is 17 ft., that of the second and third stories is 15 ft. The windows are large and numerous. Ribbed glass is used in all but the lower sashes. All structural steel, window frames, racks, and bins and the walls up to a height of 5 ft. are painted a rich green. The balance of walls and ceilings is covered with white cold water paint.

The entire industrial equipment was designed and constructed by the B. F. Sturtevant Company, in the effort to secure something better than the market afforded. The outfit comprises the industrial railway system including the platform, coal, charging and dump cars, ladle trucks, truck ladles and turn-tables; the general factory equipment consisting of cast iron bench legs, electric hoists, wash-sinks, shelf-brackets for pattern storage, etc., the manhole and catch basin covers and frames, trench cover plates, hangers and the like. All of the buildings are heated and ventilated by the Sturtevant system. In the machine shop the hot air pipes are hidden beneath the second floor wall benches and deliver most of the air downward to the first floor. The fan and erecting shops are supplied through an underground duct which delivers the hot air to external vertical flues upon one side of the building, which in the case of the fan shop are located 40 ft. on centres and discharge the air across the building above head level.

CAR JOURNAL LUBRICATOR.

The Harrison car journal lubricator, illustrated herewith, is made to fit the various sizes of standard M. C. B. journal boxes and is the result of several years of experimental work. It is claimed that this is the only device that prevents the lubricant from overflowing from the box after it reaches the height of the dust guard chamber and raises the oil clear to the journal without overflowing. It is also claimed that less than 25 per cent. of the ordinary amount of oil and waste is required to pack it, and in support of this a test on the Lake



HARRISON LUBRICATOR, PACKED FOR SERVICE.

Shore & Michigan Southern Railway is cited, where a car with sealed boxes, containing 2½ pints of oil and 8 ounces of waste, ran over eight thousand miles, using less than one ounce of the lead lining of the brass. With the same amount of material, another car ran over ten thousand miles with sealed boxes.

Another important feature of these lubricators is the oil chamber in the back, which gives the bearings as perfect lubrication from the rear as from the front and overcomes the difficulty of getting oil to the rear of the journal. It will further be observed that as the lubricators hold all the lubricant and practically provide a double chamber in the back of the journal box, the packing is nearly all housed, and what sand sifts into the box falls to the bottom and is kept out of the waste. These lubricators are pressed out of one sheet of steel and resiliently mounted on malleable bases, making them practically indestructible, and after once being placed in position in the journal box need not be removed for any cause, as the box can be jacked up and the brass and wedge taken out by simply removing the waste from the lubricator as from an ordinary oil box. They are made by the Harrison-Williams Company, of Toledo, Ohio.

Why Driving Axles Should Be Bored.—A couple of years ago, while the finishing cut was being taken on a steel driving axle in a lathe, the operator noticed in the freshly cut surface what appeared to be a small flaw. On testing this with a pin the pin disappeared, and quite a length of fine wire followed it. On taking out a transverse slice of the axle at this point a cavity was found in the metal, which would hold half a pint or more. The walls of the cavity were perfectly clean and bright, and but for the fact that the finishing cut just happened to open up the cavity a trifle its presence would not have been suspected, and the axle would have gone into service. It is perhaps safe to say that one-quarter, or possibly one-third, of the cross sectional area of the axle was embraced in the cavity. We have seen a number of such cases, and, unfortunately, the phenomenon is not rare. Almost any practical steel maker, when asked for the cause of such a cavity in what is apparently a solid piece of metal, would probably laconically answer, "careless heater." In order to understand this statement, it is necessary to say that many driving axles, even when they are finished, are about 11 ins. in diameter, and that the bloom from which they are forged is considerably larger. If now such a bloom when cold is put into a hot furnace, the outside layers get hot long before the inside has begun to rise much in temperature. A severe strain due to the greater expansion of the outside layers is accordingly set up, which strain is enough occasionally to actually rupture the inside. Subsequent forging opens out this rupture into a cavity. The rupture is usually accompanied by a noise like a pistol shot. The unfortunate part of the business is that, there being a number of blooms in the furnace at one time, it is impossible to tell which one has yielded to the strain. As would be expected, the larger the axle the more common this defect, and we know of one large railroad that bores a 2-in. hole through every axle over 8 ins. in diameter that is destined for passenger service. The boring of the hole enables the cavity to be discovered, either by the behavior of the drill, or by sight examinations after the hole is finished. It is interesting to know that something over 2 per cent. of all axles bored are found defective in this way.—*Dr. C. B. Dudley, before American Society for Testing Materials.*

Milling Machine Efficiency.—When a large variety of work has to be milled, in which cutters of greatly varying sizes have to be used, one would naturally select the machines which offer the widest range of speeds and feeds. One of the greatest advances in the construction of milling machines has been to provide them with range of speed and feed which will practically give the same peripheral speed of cutter, and proportionate rate of feed from the minimum to the maximum capacity of the machine. The wage cost of operating machines on general work of varying character will naturally increase, as it is only in the hands of a highly intelligent mechanic who thoroughly understands the details of a machine and the possibilities of milling that the best results can be secured. Given, however, a competent man, a good wage does not spell high cost of production, but is an unmistakable economy. There is no machine in the workshop which is so much influenced for better or for worse in proportion to the efficiency of its tools as the milling machine. The secret of

its failure is immediately manifest wh
is use engaged in a tug-of-war as to w
the material or the material will rem
then ends in a drawn game, which wh
itself into a loss of engine power, and
innocent milling machine. It is adv
managers to give more attention to t
tenance of efficient cutters for milling
toolroom facilities for keeping them i
these points being well attended to,
simply be a delusion and a snare.—
Coventry (England) Engineering Soci

BOOKS.

Railway Provident Institutions in Eng
By M. Riebenack, Controller Penns
delphia, Pa.

This is a consolidation of reports pre
mission to the International Congress
ist for countries using the English lang
the seventh session of the Congress held
ist May. This is the most complete c
subject now available, and in view of th
subject of pension systems by American
invaluable aid to those who are given th
ing out such systems. This admirable w
relief systems, pension or retirement pr
hospital service, savings funds, co-oper
library institutes, loan provisions and
record of facts of actual practice on rail
clusions and "addenda" present some ob
the experience and exhaustive study of
welfare of employees. The book should
not only among railroad officials but amon
charge of large bodies of men in any servi

Civil Engineering. A Text Book for a S
Col. G. J. Fiebeger, U. S. Army. 8
figures. Cloth. John Wiley & Son
New York. $5.00 net.

The author presents in this volume a co
comprising those topics which are deeme
Point cadet to study, in order that he may
maintenance and repair of engineering
gue, and to effect their destruction in
and rapidity. In consequence of this limi
muted which a complete course in civil
plan. Railroad engineering and survey
few chapters only are given to hydrau
and but one to highway engineering. Th
chapters are devoted to a theoretical tre
statics, and to their application in
masonry, and metal structures, together
physical properties of these substances,
foundations. As a text-book for use in
in thorough courses in civil engineering
Neither would it be of much value as
practicing civil engineer since its treatm
of structural design is far too brief to
the subject is discussed more exhaustive
ly in a number of standard works. I
value to those engaged in other professi
mechanical and electrical engineering, wh
acquire a limited knowledge of c
tions.

Berlin-Zossen Electric Railway Tests of
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its failure is immediately manifest when one sees the cutters in use engaged in a tug-of-war as to whether they shall move the material or the material will remove them. This trouble often ends in a drawn game, which when summed up resolves itself into a loss of engine power, and a condemnation of the innocent milling machine. It is advisable for foremen and managers to give more attention to the purchase and maintenance of efficient cutters for milling machines, and proper toolroom facilities for keeping them in order, as apart from these points being well attended to, milling machines will simply be a delusion and a snare.—*Mr. Deakin before the Coventry (England) Engineering Society.*

BOOKS.

Railway Provident Institutions in English-Speaking Countries. By M. Riebenack, Controller Pennsylvania Railroad, Philadelphia, Pa.

This is a consolidation of reports prepared by the author for submission to the International Congress as reporter on this subject for countries using the English language, in connection with the seventh session of the Congress held at Washington, D. C., last May. This is the most complete collection of data on this subject now available, and in view of the general interest in the subject of pension systems by American railroads, it will be an invaluable aid to those who are given the responsibility of working out such systems. This admirable work covers insurance and relief systems, pension or retirement provisions, superannuation, hospital service, savings funds, co-operative schemes, libraries, literary institutes, loan provisions and welfare work. It is a record of facts of actual practice on railroads. The author's conclusions and "addenda" present some observations gained by his wide experience and exhaustive study of this vital problem of the welfare of employees. The book should have wide distribution, not only among railroad officials but among men having responsible charge of large bodies of men in any service.

Civil Engineering. A Text Book for a Short Course. By Lieut.-Col. G. J. Fiebeger, U. S. Army. 8vo, xiv. 573 pages, 180 figures. Cloth. John Wiley & Sons, 43 East 19th street, New York. $5.00 net.

The author presents in this volume a course in civil engineering, comprising those topics which are deemed essential for the West Point cadet to study, in order that he may be prepared to direct the maintenance and repair of engineering structures in times of peace, and to effect their destruction in war with thoroughness and rapidity. In consequence of this limited scope much has been omitted which a complete course in civil engineering should comprise. Railroad engineering and surveying are not considered, three chapters only are given to hydraulics and allied subects, and but one to highway engineering. The remaining twenty-three chapters are devoted to a theoretical treatment of the principles of statics, and to their application in the design of wooden, masonry, and metal structures, together with a discussion of the physical properties of these substances, and a brief article upon foundations. As a text-book for use in engineering schools giving thorough courses in civil engineering it is not well adapted. Neither would it be of much value as a reference book for the practicing civil engineer since its treatment of all subjects except structural design is far too brief to be of much service, while this subject is discussed more exhaustively and with equal clearness in a number of standard works. It should, however, prove of value to those engaged in other professions such as architecture, mechanical and electrical engineering, who may find it necessary to acquire a limited knowledge of certain civil engineering problems.

Berlin-Zossen Electric Railway Tests of 1903. A Report of the Test Runs made on the Experimental Berlin-Zossen Railway in 1903. Translated from the German by Zianz Wels, with an introduction discussing the general subject of train resistance. By Louis Bell. Published by the McGraw Publishing Company, 114 Liberty street, New York, 1905. Price, $3.00.

This book of seventy-four pages of text, with eighteen illustrations and thirty-eight full page diagrams, presents official information concerning the high speed experiments upon the special track between Berlin and Zossen for the development of fundamental data on the subject of high speed travel. This record is unique in that it affords the first accurate knowledge of train and car resistance at speeds of 100 miles per hour and upwards. The experiments themselves develop the possibility and feasibility of transmitting power in large quantities to a car moving at extremely high speeds. The experiments also develop valuable information concerning the behavior of cars and road beds at these speeds and shows the limitation of even specially good construction of track. While the record at hand does not cover complete trials it presents the results of the most important tests which were made in the latter part of the year 1903, placing them at the disposal of those who are familiar only with the English language. The work of the translator is commendably complete and is extended to all of the data and to the diagrams of results. The work includes comments upon the commercial practicability of high speeds and includes a discussion of cost, fares and passenger earnings. Specially valuable information is included concerning air and train resistance, the power required for acceleration and a large number of drawings, showing the details of construction and attachment of the motors. This is an exceedingly valuable document, which will be appreciated by all students of high speed transportation.

PERSONALS.

Mr. F. L. Hunter has been appointed purchasing agent of the El Paso & Southwestern Railway.

Mr. Hugh Craig has been appointed general car inspector of the Western lines of the Canadian Pacific, with headquarters at Winnipeg, Man.

Mr. J. H. Eaton has been appointed assistant master car builder of the Western lines of the Canadian Pacific Railway, with headquarters at Winnipeg, Man.

Mr. A. S. Grant has been appointed master mechanic of the Missouri division of the Missouri Pacific Railway at De Soto, Mo., to succeed Mr. W. J. Haynen, resigned.

Mr. H. W. Jacobs has been appointed engineer of shop methods and tools of the Atchison, Topeka and Santa Fe Railway, with headquarters at Topeka, Kansas.

Mr. W. J. Haynen has been appointed superintendent of motive power of the Detroit, Toledo & Ironton at Springfield, Ohio. He was formerly master mechanic of the Missouri Pacific at De Soto, Mo.

Mr. Carl A. Strom of Chicago, who resigned the position of mechanical engineer of the Ilinois Central R. R. in May, 1904, to become mechanical engineer of the Isthmian Canal Commission, at Panama, has recently been promoted to the position of superintendent of motive power and machinery of the Panama Canal.

Mr. M. E. Wells has been appointed traveling master mechanic of the Wheeling & Lake Erie, the Wabash Pittsburgh Terminal and the West Side Belt Railroads. He will have supervision over roundhouse service, the care of locomotive boilers on the road and at terminals, and the character of the locomotive water supply.

Just before going to press word was received of the sudden death under exceptionally sad circumstances of Mr. W. P. Appleyard, superintendent of equipment of the Pullman Company. Mr. Appleyard was 49 years of age and one of the best and most favorably known authorities on car building of the time. His unusual ability was combined with a remarkable personality. His quiet dignity uprightness of character and frank friendliness brought admiration from all who knew him. He was educated in engineering and architecture. In 1888 he entered the service of the Pullman Company as mechanical inspector, and was promoted to the position of superintendent of repairs. In 1893 he became master and builder of the New York, New Haven & Hartford Railroad. He returned to the Pullman Company as superintendent of equipment in February of last year. His death brings sadness and keen sense of personal loss to hosts of friends and associates.

CATALOGS.

Wrenches.—A catalog of the drop forged machine wrenches made by the Billings & Spencer Company, Hartford, Conn.

Pneumatic Tools.—Catalog F from the Cleveland Pneumatic Tool Company of Cleveland, Ohio, is devoted entirely to their pneumatic hammers and drills.

Air Compressors.—Bulletin L-508 received from the Laidlaw-Dunn-Gordon Company, Cincinnati, Ohio, gives a complete, illustrated, detailed description of the improved Cincinnati air compressors.

Electric Motors.—Bulletin No. 261 from the Triumph Electric Company, Cincinnati, Ohio, describes their new steel frame multipolar motors, a description of which appears on another page of this issue.

Reamers and Core Drills.—A revised price list from the Three Rivers Tool Company, Three Rivers, Mich., of the Matthews high speed core drills and reamers. These tools have blades of high speed steel brazed into soft steel bodies.

Motors and Generators.—Bulletin No. 51 issued by the Northern Electrical Manufacturing Company, Madison, Wis., is devoted to a detail description of their generators and motors with "ring" type fields. These are for large ratings, and if desired may be equipped for variable speed.

Crane Valves.—The Crane Company of Chicago have issued a four-page circular illustrating their renewable spring disc brass valves made in globe, angular and cross forms, suitable for working pressure up to 150 lbs. The circular illustrates and describes the valves and discs and presents sizes and prices of all the varieties furnished.

Engines and Dynamos.—Bulletin No. 16 issued by the Ridgway Dynamo & Engine Company, Ridgway, Pa., gives the names of a large number of customers who have from one to twenty McEwen engines and Thompson-Ryan dynamos in daily operation, and who will be glad to answer questions of prospective purchasers concerning these machines.

Electric Traveling Hoists and Trolleys.—The Niles-Bement-Pond Company, 111 Broadway, New York, have issued a very interesting catalog of their electric hoists and trolleys, and have devoted considerable space to an application at the Ramapo Iron Works, Niagara Falls, N. Y. The system described could be used to advantage for handling material in railway store-houses and scrap yards and a description of it will be found on another page of this issue.

Mallet Articulated Compound Locomotive.—The American Locomotive Company are issuing an attractive publication which describes in detail the large Mallet compound built for the Baltimore & Ohio Railroad, and considers the advantages of this type of construction and compounding. It also contains a number of interesting comments from the technical press on the design and working of the B. & O. engine, which is the largest and most powerful locomotive ever built.

Pipe Joints.—Advance circulars have been received from the Crane Company, Chicago, Ill., describing their Cranelap extra heavy flanged pipe joints with flanges made from cast iron, ferrosteel, malleable iron, cast steel or weldless steel, suitable for working pressures up to 250 lbs.; also their Craneweld flanged pipe joints with wrought steel flanges welded on, suitable for pressures up to 250 lbs. The latter circular also illustrates the different operations on and methods of facing extra heavy companion flanges suitable for working pressures up to 250 lbs.

Baldwin Locomotive Works.—Nos. 51 and 52 of the "Record of Recent Construction" of the Baldwin Locomotive Works have been received. The former illustrates a number of locomotives built for various classes of service, beginning with the four-cylinder balanced compound for the New York Central and Hudson River Railroad, this being the 25,000th locomotive produced by these works. The latter publication presents the subject of solid forged and rolled steel wheels as manufactured by the Standard Steel Works at Burnham, Pa. It illustrates the works, the process of manufacture, discusses the merits of steel wheels for passenger and freight service, presents physical tests and chemical analysis and includes a number of designs of standard steel wheels for various classes of service.

NOTES.

Hollow Staybolts.—The Hollow Staybolt Company, Cuyahoga Falls, Ohio, have orders for hollow staybolt iron bars for export to a leading railroad of Japan and for the Imperial Railway of North China.

Electrical Controller & Supply Company.—Mr. H. F. Stratton, who has been connected with the main office at Cleveland, Ohio, has accepted the position of New York representative, with offices at 136 Liberty street, New York City.

Oil and Gas Engine Patents.—A digest of United States patents of air, caloric gas and oil engines, including the years from 1789 to July, 1905, has been prepared by Mr. James T. Allen, examiner United States Patent Office, Washington, D. C., which is soon to be published. It contains 2,000 pages in three volumes with claims and briefs, including references and decisions.

Resorts and Tours.—This is a vacation directory and encyclopaedia for the traveler. It contains 90 pages of delightful descriptive reading, excellent half tones and a list of about 1,500 resorts, including rates, hotels and railroad routes. It is mailed free on application by postal card, to Mr. D. J. Flanders, general passenger and ticket agent, Boston & Maine Railroad, Boston, Mass.

Sturtevant Roundhouse Heating.—Three of the new roundhouses of the Erie Railroad are to be equipped by the B. F. Sturtevant Company, of Boston, Mass., with complete systems of heating and ventilation, particularly applied for thawing out engines during the winter. These include a 10-stall house at Marion, Ohio, a 14-stall house at Kent, Ohio, and a 10-stall house at Hammond, Ind.

American Locomotive Company's Earnings.—The fourth annual report of the president of the American Locomotive Company shows that in the year ending June 30th the gross earnings were $24,150,201.06, a decrease of $8,918,549.50 from the earnings of the previous year. The expenses were $19,796,533.49, a decrease of $7,608,451.91, leaving a net earnings of $4,353,667, which is $1,310,097 less than the previous year. After providing for interest and dividends and for permanent investments a surplus of $607,924.26 is carried to the credit of profit and loss account.

Locomotive Appliance Company.—At the meeting of the board of directors of the Locomotive Appliance Company August 21st, the election of officers and an executive committee, for the ensuing year, resulted as follows: Mr. Ira C. Hubbell, president; Mr. Willis C. Squire, vice-president; Mr. Clarence H. Howard, vice-president; Mr. J. J. McCarthy, vice-president; Mr. J. B. Allfree, consulting engineer; Mr. E. B. Lathrop, treasurer; Mr. W. H. England, secretary. And the president, Mr. Willis C. Squire and Mr. E. B. Lathrop were elected the executive committee.

A Large Heating Problem.—The magnitude of the heating proposition in a large railroad shop is well exemplified in the case of the new shops of the Southern Railway Company, at Spencer, N.C. The machine shop alone contains 4,500,000 cu. ft., and requires for its heating two special steel plate fans, 9½ ft. in diameter, driven by 10 x 10 horizontal engines and installed in connection with a total of about 21,000 ft. of 1-in. pipe massed in individual heaters. The entire equipment was furnished by the B. F. Sturtevant Company, of Boston, Mass., and is designed to maintain a temperature of 60 deg. when the outdoor temperature is 10 deg. F. Distribution is made through a system of overhead piping with discharge pipes leading down to within about 10 ft. of the floor.

Chicago Pneumatic Tool Company.—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, returned on September 8 from Europe where the past six weeks were spent in the interest of the foreign business. While abroad the Fraserburgh and Berlin factories were started up and manufacturing arrangements were perfected in Russia. All factories are now running in good shape with sufficient business to keep them constantly occupied for several months, and the outlook generally is the most satisfactory of any period in the history of the company. Domestic inquiries are extremely heavy for all classes of tools and appliances. One hundred and fifty-seven Franklin compressors have been sold during the past ninety days.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

NOVEMBER, 1905.

CONTENTS.

EAST MOLINE LOCOMOTIVE SHOPS.

ROCK ISLAND SYSTEM.

I.

The magnificent locomotive repair shops of the Rock Island System at East Moline, Ill., were planned, erected and equipped for operation in less time than is usually required to plan shops of equal size and capacity, and when this is considered in connection with the fact that their cost was very reasonable and that they possess radical features, making their operation very convenient and economical, and that they have been designed with a view to durability and low cost of maintenance, it reflects considerable credit for ability and foresight on the committee which had this work in charge.

On January 15, 1903, a committee, consisting of Mr. George F. Wilson, superintendent of motive power, who was shortly afterwards succeeded by Mr. M. K. Barnum; Mr. C. A. Seley, mechanical engineer, and Mr. S. F. Forbes, assistant purchasing agent, was appointed and authorized to submit plans and recommendations covering the general questions of layout, power, lighting, heating and tool equipment for shops capable of repairing sixty-five engines per month. They were also to consider car department repair shops in regard to general dimensions and location, although up to the present time no provision has been made for their erection. The committee report made to the management, with about three weeks' time for its preparation, was approved, and the committee was continued to assist in making detail plans, specifications and contracts for the equipment and its arrangement. Mr. C. H. Wilmerding, consulting engineer, of Chicago, was engaged to assist with this work, and also undertook the inspection of the erection of the power-house machinery and equipment and all piping and wiring. The buildings were designed and constructed by George B. Swift Company, under the personal supervision of Mr. George F. Jenkins, who was specially well equipped for this work because of his extensive experience in the construction and maintenance of railroad buildings. The work on the buildings was under the general supervision of the chief engineer of the railroad, Mr. J. F. Stevens, and later his successor, Mr. W. L. Darling. Mr. J. M. Brown was appointed engineer in charge for the railroad company. Actual construction was started May 1, 1903; the buildings were completed in a little more than six months, although thirty-one days of that time was entirely lost, due to rain; and the plant was placed in operation the following February.

LOCATION AND CAPACITY.

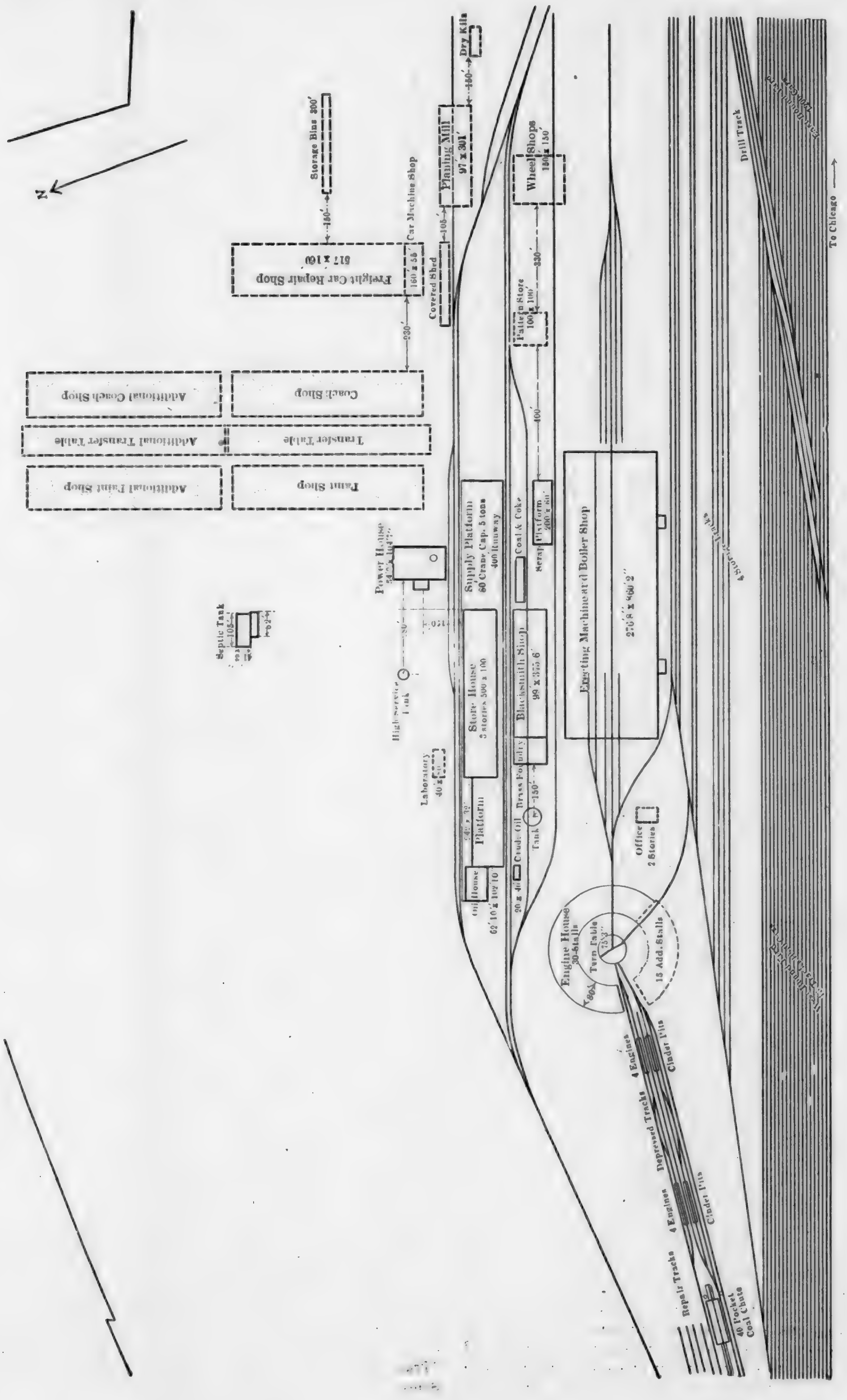
East Moline is about 175 miles west of Chicago, near the cities of Moline, Rock Island and Davenport. Crossing the Mississippi River at Rock Island and Davenport, the Rock Island System diverges in three directions: to the northwest to St. Paul, Minneapolis and Watertown; to the west to Omaha and Denver, and to the southwest to Kansas City and beyond. The importance of having a repair shop at this point is evident from the fact that the four divisions which enter East Moline have about 1,200 locomotives.

The shop site lies in a depression between the valleys of the Mississippi and Rock Rivers, about two miles from each, and is thirty-eight feet above the low-water level in the Mississippi River, which, at this point, rises about fifteen feet during high water. The soil is sandy and very favorable for the construction of the buildings. The shops were designed to turn out about sixty-five engines per month and, in addition, to do manufacturing for the system. The general storehouse for the entire system is located here.

GENERAL DESCRIPTION.

The plot of ground upon which the yards and shops are located is about one mile wide and one and a half miles long and at the time the layout was decided upon it contained no permanent structures or tracks except the main tracks at one side of the property and therefore, unlike many of the recent large shop installations, there were practically no restrictions as to the shape and the arrangement of the buildings. On the layout plan, those buildings which are shown by full lines, which include the erecting, machine and boiler shops, blacksmith shop, storehouse, oil houses, roundhouse and power house, have already been constructed. The buildings indicated by dotted lines have not yet been erected. The freight yards, ash pits and the coaling station are now in the course of construction. The freight yard, which lies between the main track and the shop buildings, is one and a half miles long and five hundred feet wide, and will have a capacity for 3,000 cars. In addition, there are nine miles of track for the use of the shops and storehouse. One track extends through the erecting shop, one through the boiler shop and one through the blacksmith shop, while the storehouse is served by two tracks on each side and the power house by one track. At the east end of the erecting shop are tracks for the storage of wheels.

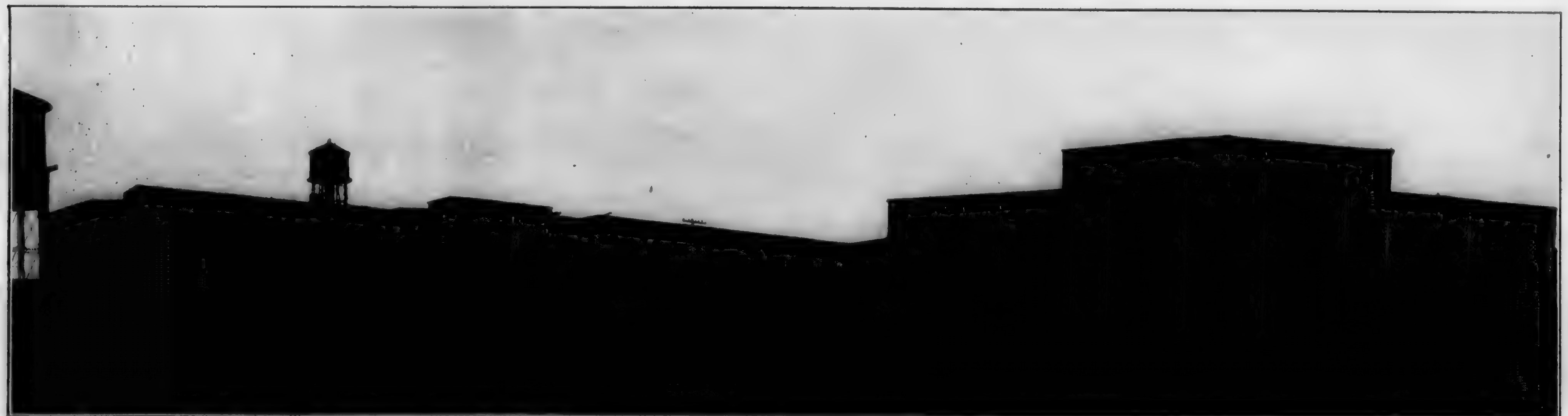
The erecting, machine and boiler shops are under one roof. The erecting shop occupies the central bay of the building, while the boiler and tank shops are on the side nearest the blacksmith shop, and the machine shop is on the other or south side of the erecting shop. The engines are taken into the erecting shop at the east end, are stripped on longitudinally arranged pits, and are then placed on pits which are built at an angle with the center track. The final erecting work is done on longitudinally arranged pits at the west end of the erecting shop, the end nearest to the roundhouse. This arrangement will be considered more fully in a later article dealing with the equipment and operation of the locomotive shop. On page 236 of the June, 1904, journal is a discussion on the "Track Arrangements in Locomotive Shops," by Mr. C. A. Seley, which considers the advantages of this arrangement



EAST MOLINE LOCOMOTIVE AND CAR SHOPS—ROCK ISLAND SYSTEM.

(Buildings indicated by dotted lines are not yet erected.)

PANORAMIC VIEW, LOOKING FROM A HILL TO THE SOUTHWEST OF THE PLANT.



STOREHOUSE, BLACKSMITH SHOP AND LOCOMOTIVE SHOP, LOOKING FROM THE ROUNDHOUSE. PART OF THE LOW-SERVICE WATER TANK SHOWS AT THE EXTREME LEFT. THE HIGH-SERVICE TANK IS AT THE REAR OF THE STOREHOUSE.

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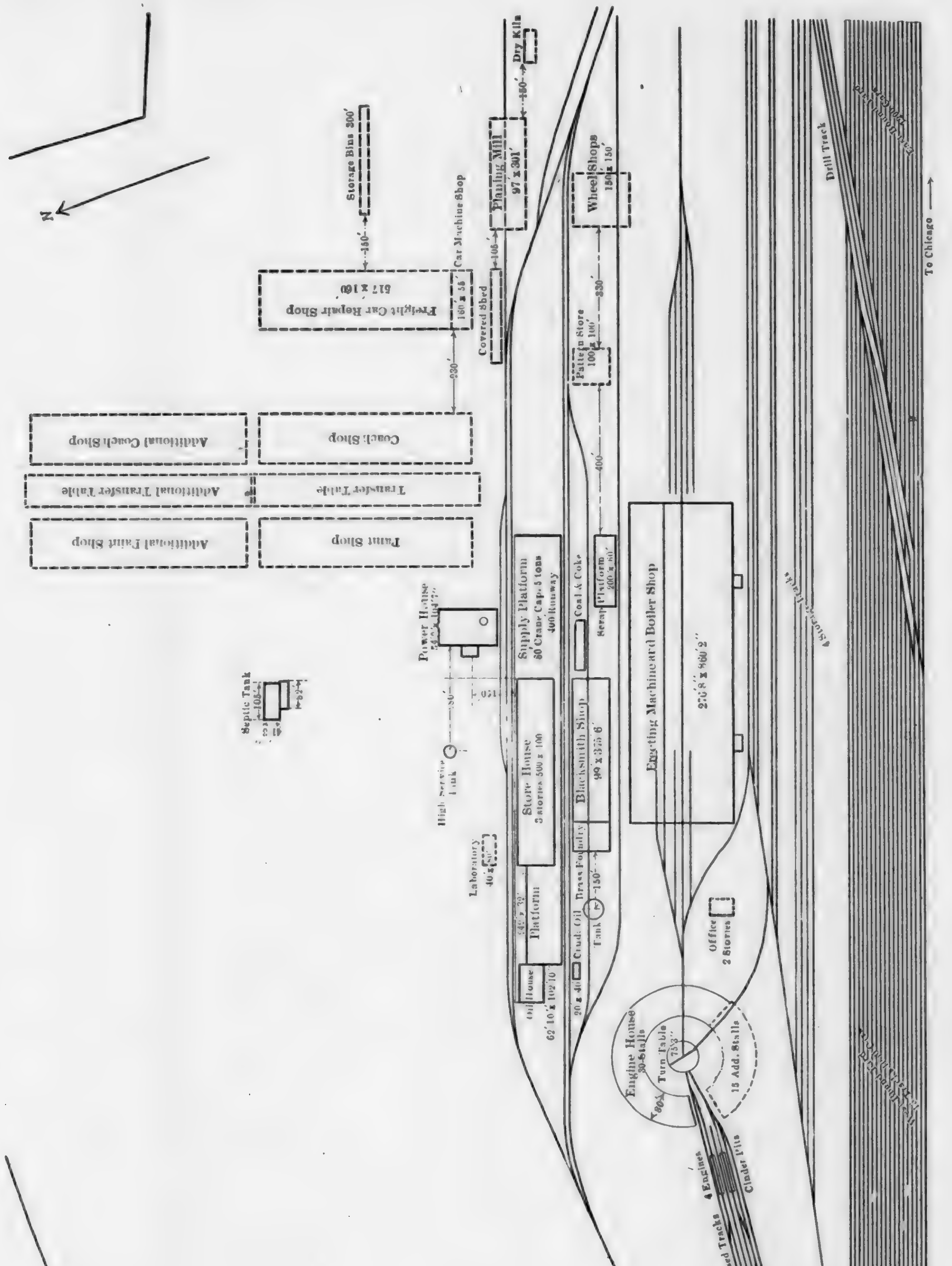

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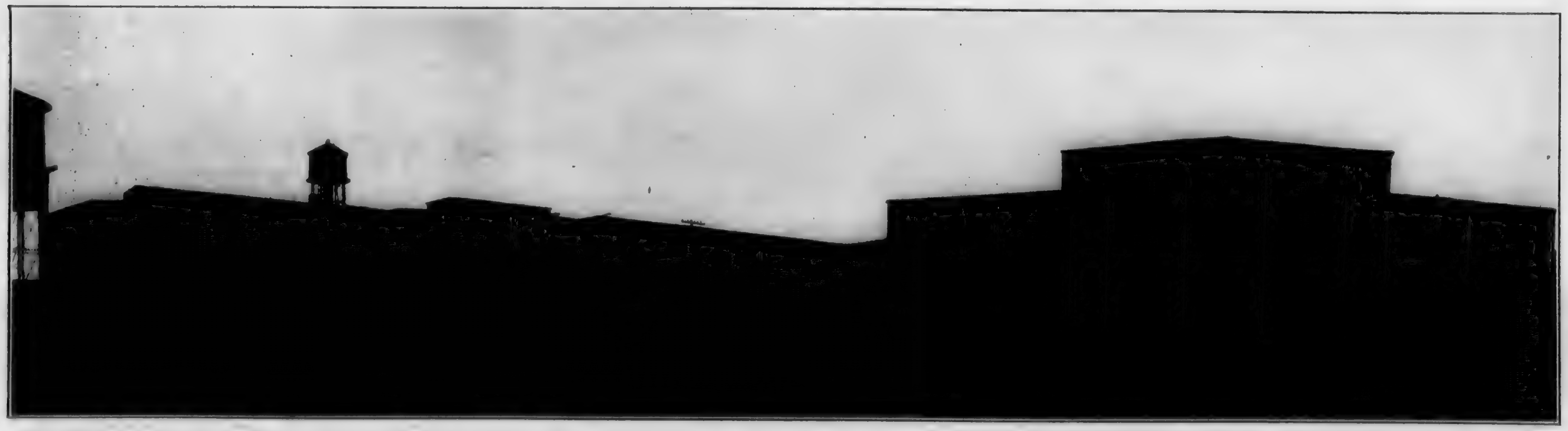

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EAST MOLINE LOCOMOTIVE SHOPS—ROCK ISLAND SYSTEM.

LOCOMOTIVE SHOP, BLACKSMITH SHOP, STOREHOUSE AND STORAGE PLATFORM AND CRANE, AND ALSO THE POWER HOUSE IN COURSE OF ERECTION.

EAST MOLINE SHOPS, ROCK ISLAND SYSTEM.

compared with the longitudinal and transverse arrangements. The blacksmith shop, the west end of which is to be used as a brass foundry, is placed between the main shop and the storehouse. The power house, storehouse and supply platforms are placed centrally with regards to the car and locomotive departments, and the blacksmith shop is so placed that it may also be conveniently reached from the car shops. Reference to the layout plan will show that a generous allowance has been made for the extension of all the buildings.

BUILDINGS—GENERAL.

The most striking features about the buildings are the splendid day-lighting, simplicity, absence of all ornamentation and the duplication of detail design, and it is largely these features which made it possible to furnish buildings of strong and durable construction and yet at a relatively low cost ($1.40 per sq. ft. for the machine, erecting and boiler shops, which includes the cost of walls, roofs, floors, crane runways, fan houses, heating, tunnels and engine pits), and it is expected that the cost of maintenance will also be reduced to a minimum. All of the buildings, with the exception of the roundhouse and storehouse, are of brick, with gravel roofs supported on steel trusses. All footings, foundations, pits and conduits are of concrete, consisting of crushed lime stone, not exceeding 2½-inch cubes, coarse, clean, sharp sand and American Portland cement in the proportion of one measure of cement, three of sand and six of stone, the proportion of sand being reduced when the stone ran small. Concrete or cement floors and engine beds have a top dressing ¾-inch thick, with a smooth, level surface. The brick is of the hard burned, common building variety, every seventh course above the foundation being a header course. All fire and battlement walls are finished with vitrified wall coping. The window sills are of Indiana Oolitic lime stone.

The roofs are designed to sustain a force of fifty pounds per square foot. The roof covering is of composition and gravel, and is constructed in the following manner. The sheathing is covered with four thicknesses of wool and roofing felt, weighing not less than fifteen pounds (for single thickness) to a square of one hundred feet; the felt is cemented together the full width of the lap. The roof is then covered with a heavy coating of roof cement and clean screened gravel is applied. The surplus gravel is then brushed off, leaving a coating of one-sixteenth of a cubic yard to a square of one hundred feet.

The windows, clerestory lanterns and doors are all glazed with heavy factory ribbed glass, all one size, 10 by 16, and the window sash and doors are made in standard sizes for all the buildings, and it is expected that this feature will materially affect the cost of maintenance. The windows are generally of two and three flight of sash, all double hung. Where three sash are used, the center one is fitted stationary. The skylights are of the Hayes pattern, with one-quarter inch wire woven glass.

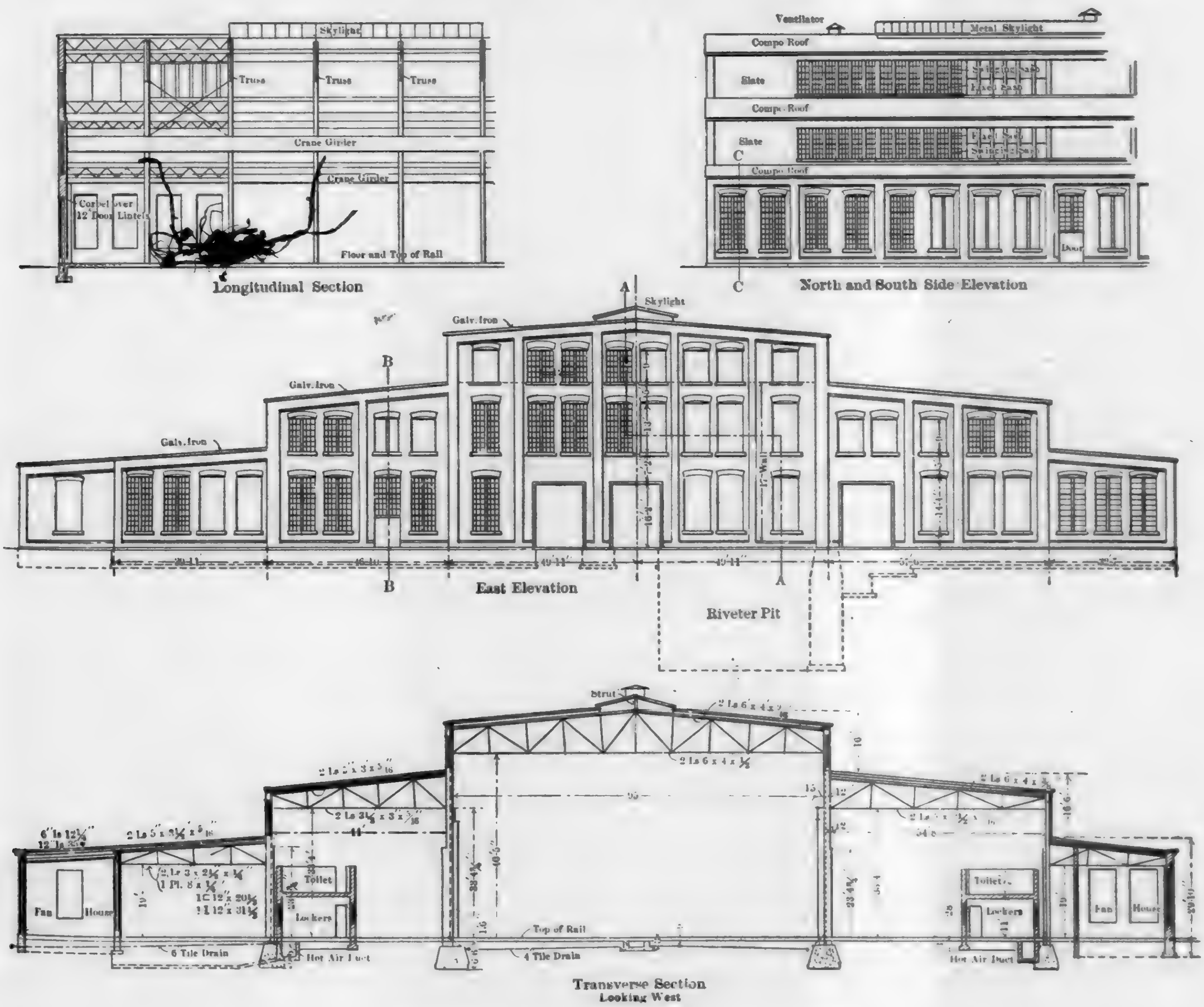
The down-spouts for roof drainage are of cast iron, heavy soil pipe, with leaded joints, and in all cases are brought down inside of the walls and are connected to the sewer with tight cement joints.

The amount of material used in the construction of the buildings will give some idea of their size, and is as follows: 22,000 barrels of Portland cement, 20,000 cubic yards of crushed stone, 5,000,000 feet of lumber, 6,000,000 bricks, 2,400 tons of structural steel, 150 tons of cast iron, 64,000 square feet of factory ribbed glass, 20,000 feet of woven wire glass skylights, and 420,000 square feet of composition roof.

MACHINE, ERECTING AND BOILER SHOPS.

The building which contains these departments is under one roof and covers about five and a half acres; it is 273 feet wide and 860 feet long inside, and is the largest shop of this kind in the United States under one roof, except for the Sayre shop of the Lehigh Valley, which is 360 feet wide and 748 feet long. The Sayre locomotive shop has the boiler shop at one end and two erecting shops, one on either side of the machine shop. Between the machine shop and each erecting shop at

INTERIOR VIEW OF THE LOCOMOTIVE SHOP.



SECTIONS AND ELEVATIONS OF THE LOCOMOTIVE SHOP.

LOCOMOTIVE SHOP, BLACKSMITH SHOP, STOREHOUSE AND STORAGE PLATFORM AND CRANE, AND ALSO THE POWER HOUSE IN COURSE OF ERECTION.
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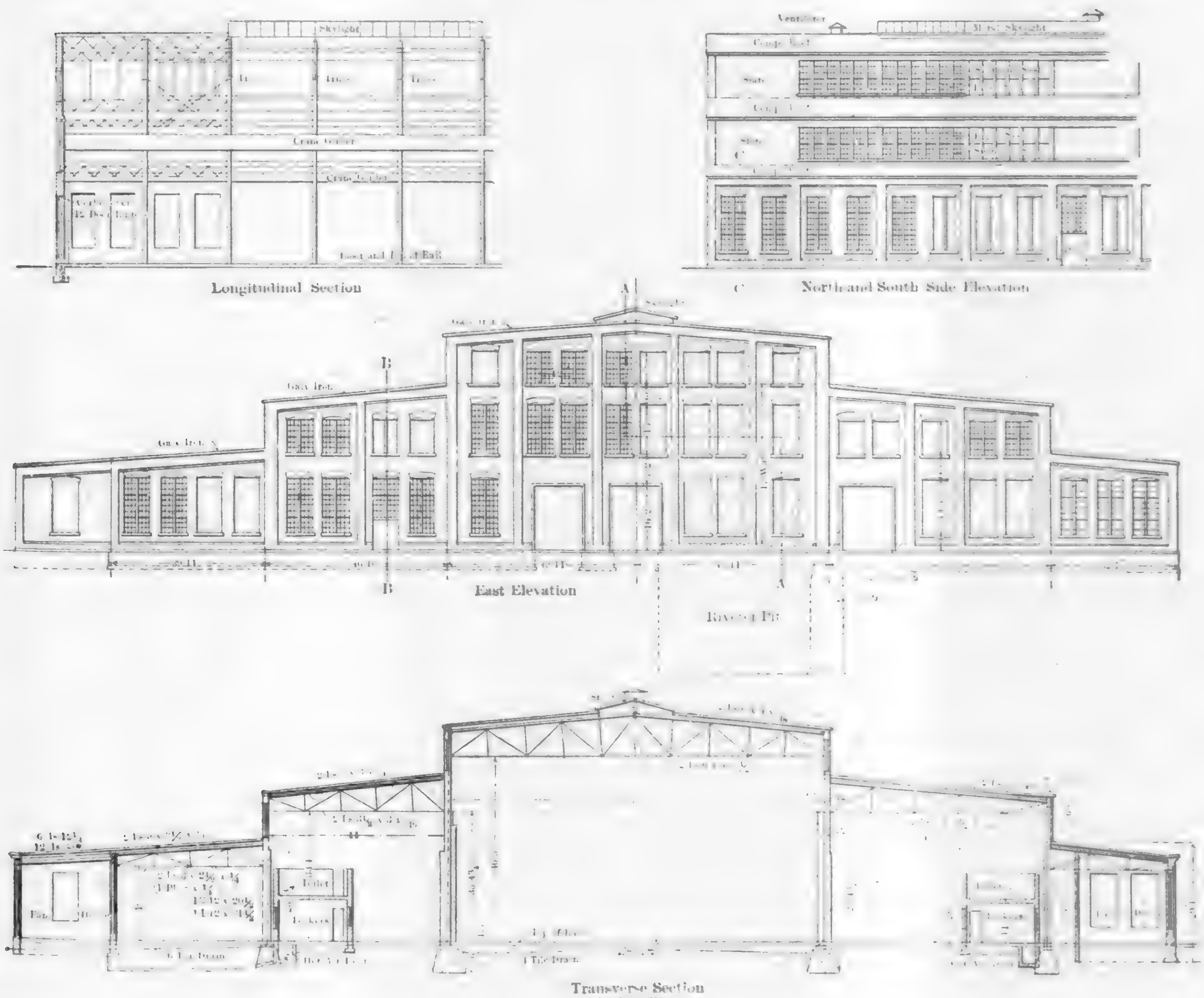
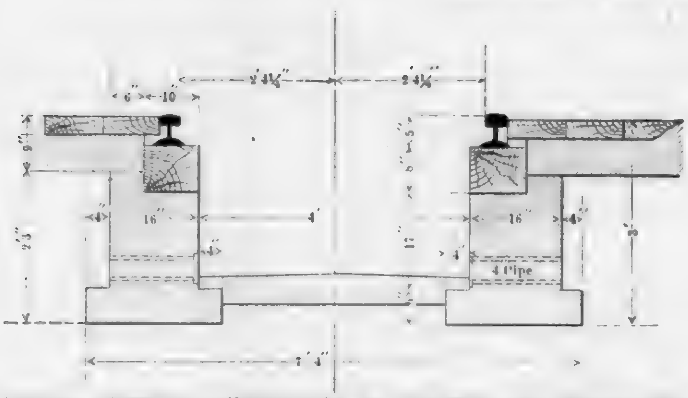
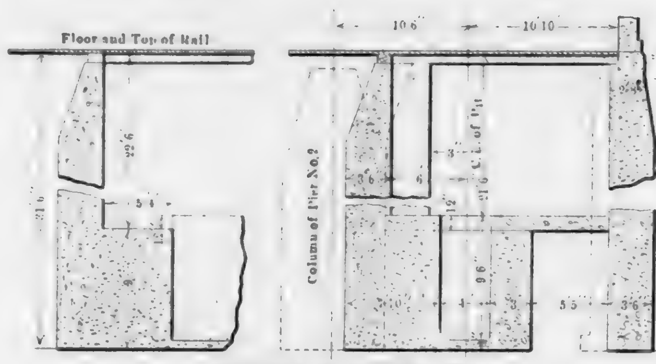


SECTIONS AND ELEVATIONS OF THE LOCOMOTIVE SHOP.

VIEW LOOKING THROUGH THE ERECTING SHOP.



SECTION SHOWING CONSTRUCTION OF STRIPPING AND REPAIR PITS.



SECTIONS OF RIVETER PIT.

Sayre is a storage space forty-two feet wide, and in the following comparisons this storage space is supposed to be divided equally for machine and erecting shop purposes.

Location.	Total Area. Ratio.	Sq. Ft.	Per Cent. of Total Erecting.	Machine.	Boiler.
Collinwood	1	129,850	28	41	31
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East Moline.......	1.84	233,961	36	31	33
Sayre	2.07	269,280	38	46	16

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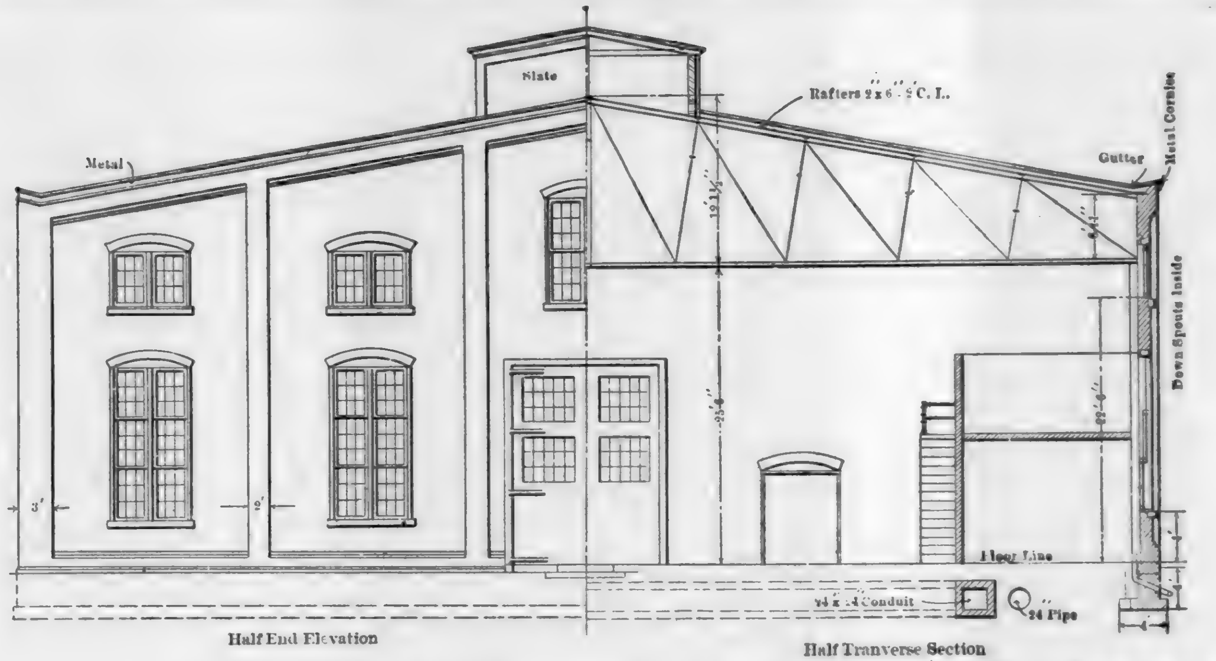

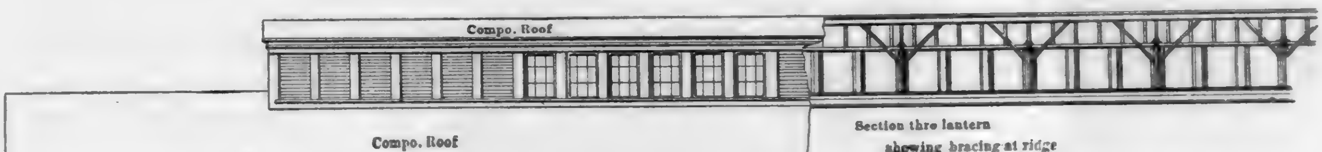

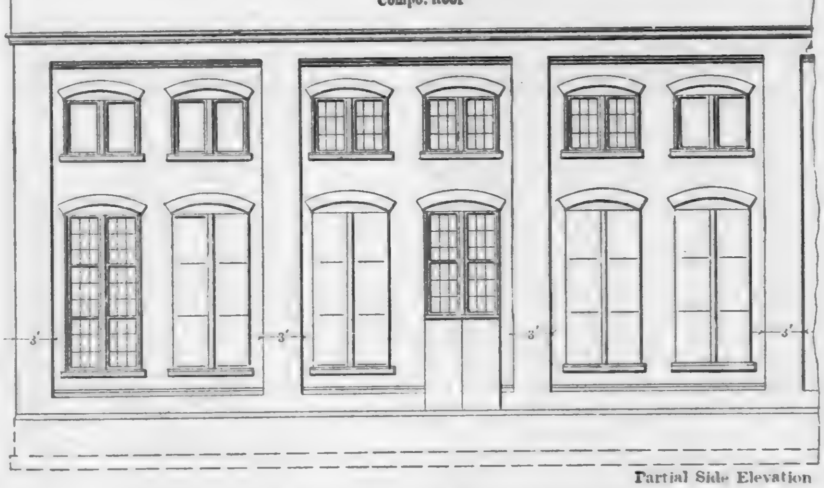

SECTIONS AND ELEVATIONS OF THE BLACKSMITH SHOP.

The floor is of 3 by 10 in. plank, carried on 4 by 6 in. sleepers, spaced four feet apart. The floor for the south bay, which contains the smaller machine tools, which do not require special foundations, is concrete filled. The 4 by 6 in. sleepers are solidly bedded on six inches of cinders, and the space between the sleepers is filled with concrete. The construction of the pits is shown in detail on one of the drawings. The arrangement of the skylight and lanterns, and also the fact that a comparatively large proportion of the side walls is devoted to windows gives this shop a diffused and excellent light; in fact, it is doubtful whether any other railroad shop in this country is so well lighted. The skylight over the erecting shop is twenty feet wide and is glazed with one-quarter inch wire woven glass in metal frames. The upper windows in the sides of the main clerestory and the lower ones in the clerestory of the wings are pivoted to operate in sections from below.

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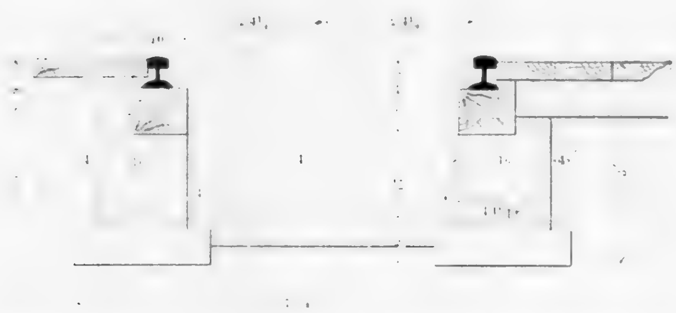
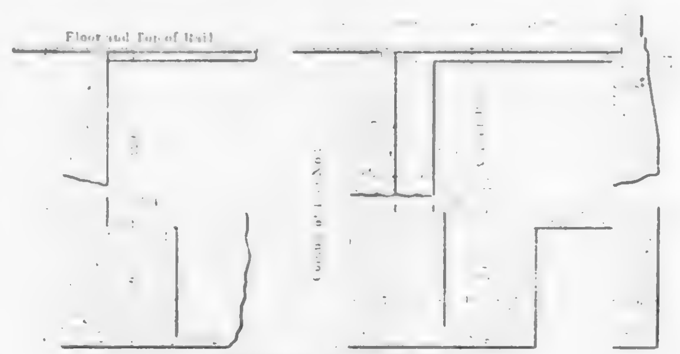
STOREHOUSE.

The storehouse building is 500 ft. long, 100 ft. wide and three stories high. It has concrete foundations, brick walls and mill construction of long leaf yellow pine. The first story walls are seventeen inches thick with 4-in. outside pilasters, while the second and third story walls are thirteen inches thick, with 4-in. outside pilasters. The first floor is four feet above the rail of the delivery tracks, and consists of 3-in. plank laid on 4 by 6 in. sleepers, spaced four feet apart, the spaces between the sleepers being filled with cinders. The second story has 3 by 6 in. D and M and the third story 2 by 6 in. D and M flooring. Two stairways lead from the first to the third floor, and there are also two platform elevators, each of 5,000 pounds capacity. The windows on the first floor are placed eight feet above the floor, so that the space may be utilized for storage.

VIEW LOOKING THROUGH THE ERECTING SHOP.



SECTION SHOWING CONSTRUCTION OF STRIPPING AND REPAIR PITS.



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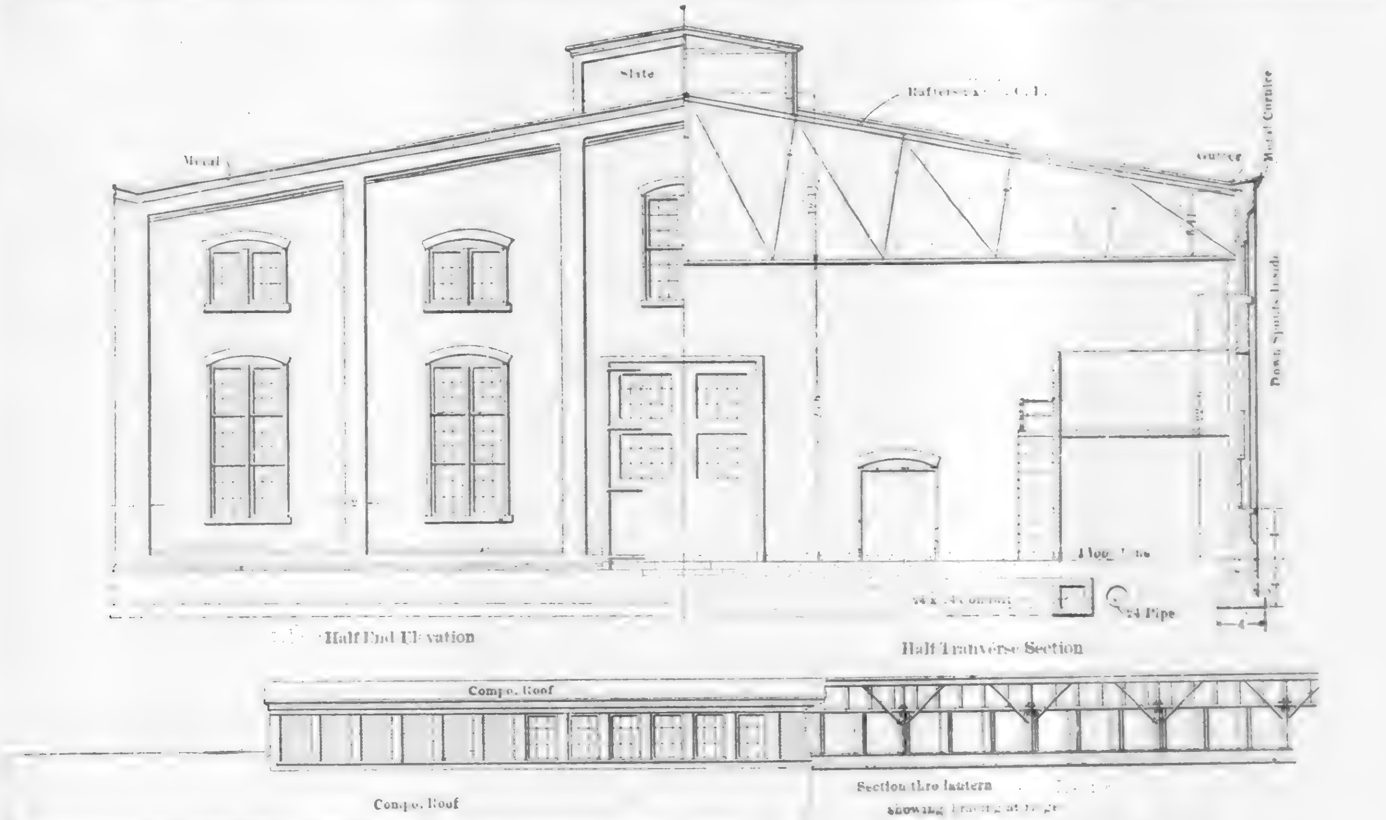

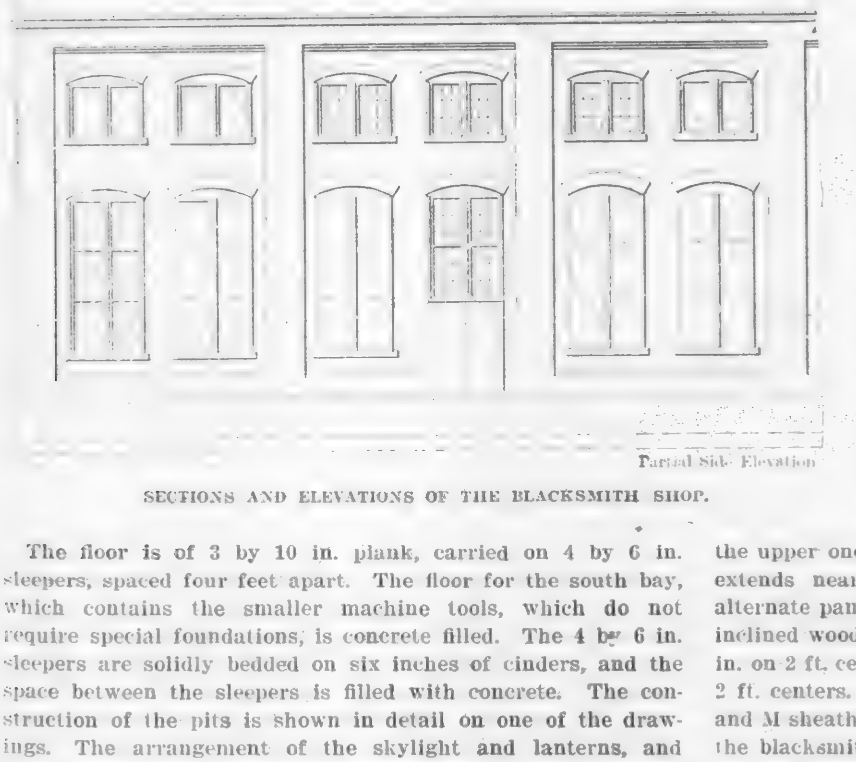

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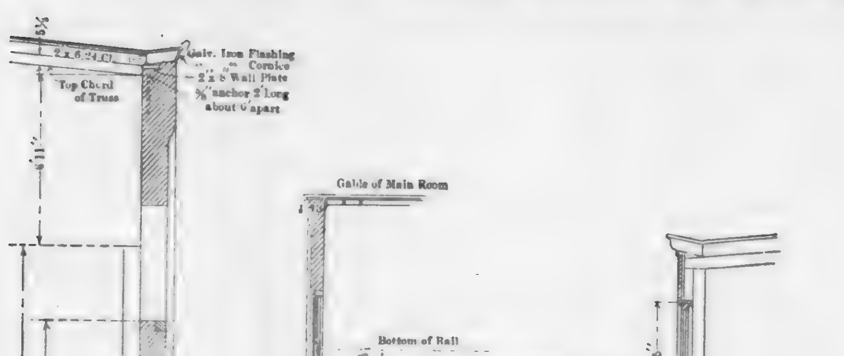
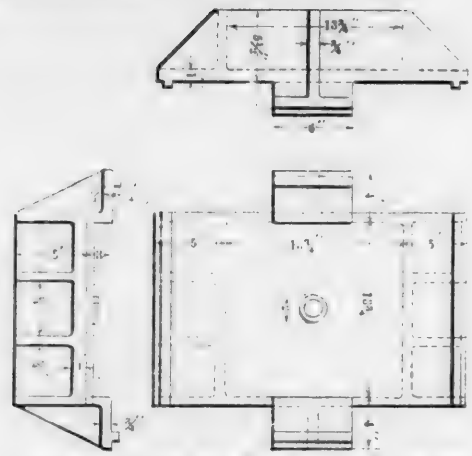
INTERIOR OF BLACKSMITH SHOP, SHOWING ROOF CONSTRUCTION.



SECTIONS OF THE WALLS OF THE BLACKSMITH AND LOCOMOTIVE SHOPS.

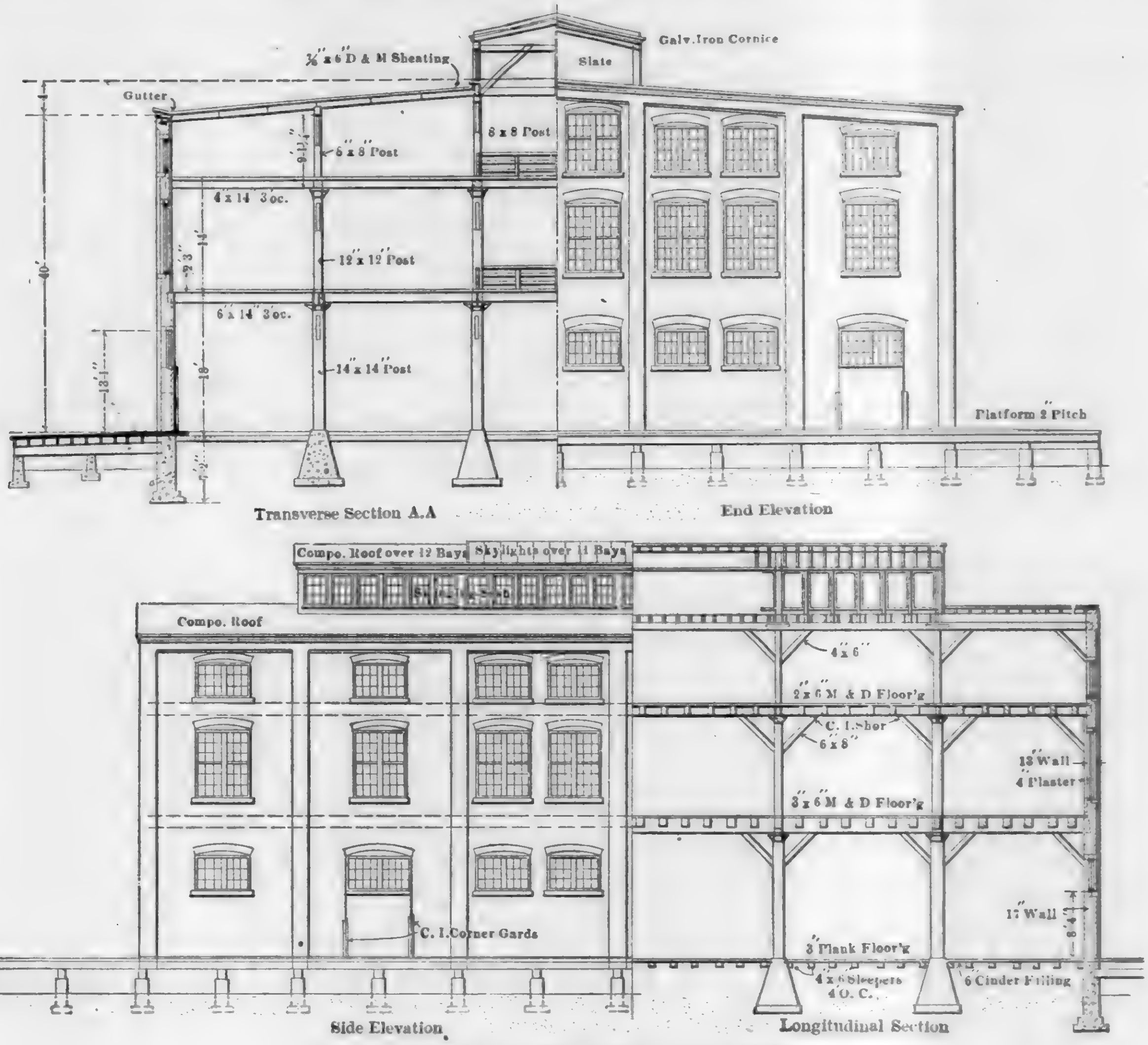


CAST IRON CAPS FOR TIMBER POSTS IN THE STOREHOUSE.

The lantern for light and ventilation is fitted with pivoted windows and a portion of its roof is furnished with skylights. In each floor beneath the skylights are light courts. The brick walls on either side of the doors are protected for a height of about six feet by heavy cast iron guards. The storage platform at the east is 134 ft. 4 in. wide and 400 ft. long. A traveling electric crane of five tons capacity, with an 80-ft. span, extends over one of the delivery tracks and part of the platform for its entire length of 400 ft. A delivery platform, 15 ft. 8 in. wide, extends along each side of the building and at the west end is a platform, 17 ft. 8 in. wide, extending to the refined oil house.

OIL HOUSES.

The refined oil house is 260 ft. west of the storehouse and is 62 ft. 8 in. by 102 ft. 10 in. It has concrete foundations, brick walls and steel roof trusses. The roof composition is carried on 1⅛ in. D and M sheathing and 2 by 6 in. rafters. The building has a basement 59 ft. 2 in. by 59 ft. 4 in., which contains nine storage tanks, six with a capacity of 12,060 gals. each, and three with a capacity of 6,170 gals. each. The basement and first floor are of finished cement, and that part of the first floor over the basement is supported on steel I beams and is reinforced between the beams by No. 16 expanded metal. The basement and first floor are connected by iron stairs. The first floor is four feet above the rails of the delivery track. The building is divided into three parts:

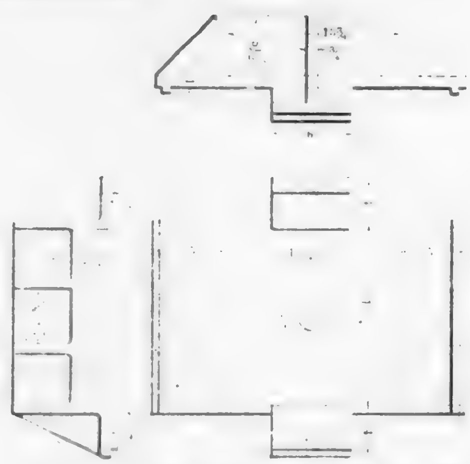


SECTIONS AND ELEVATIONS OF THE STOREHOUSE.

STOREHOUSE, STORAGE PLATFORM AND CRANE, WITH HIGH-SERVICE WATER TANK TO THE RIGHT.

INTERIOR OF BLACKSMITH SHOP, SHOWING ROOF CONSTRUCTION.

SECTIONS OF THE WALLS OF THE BLACKSMITH AND LOCOMOTIVE SHOPS.



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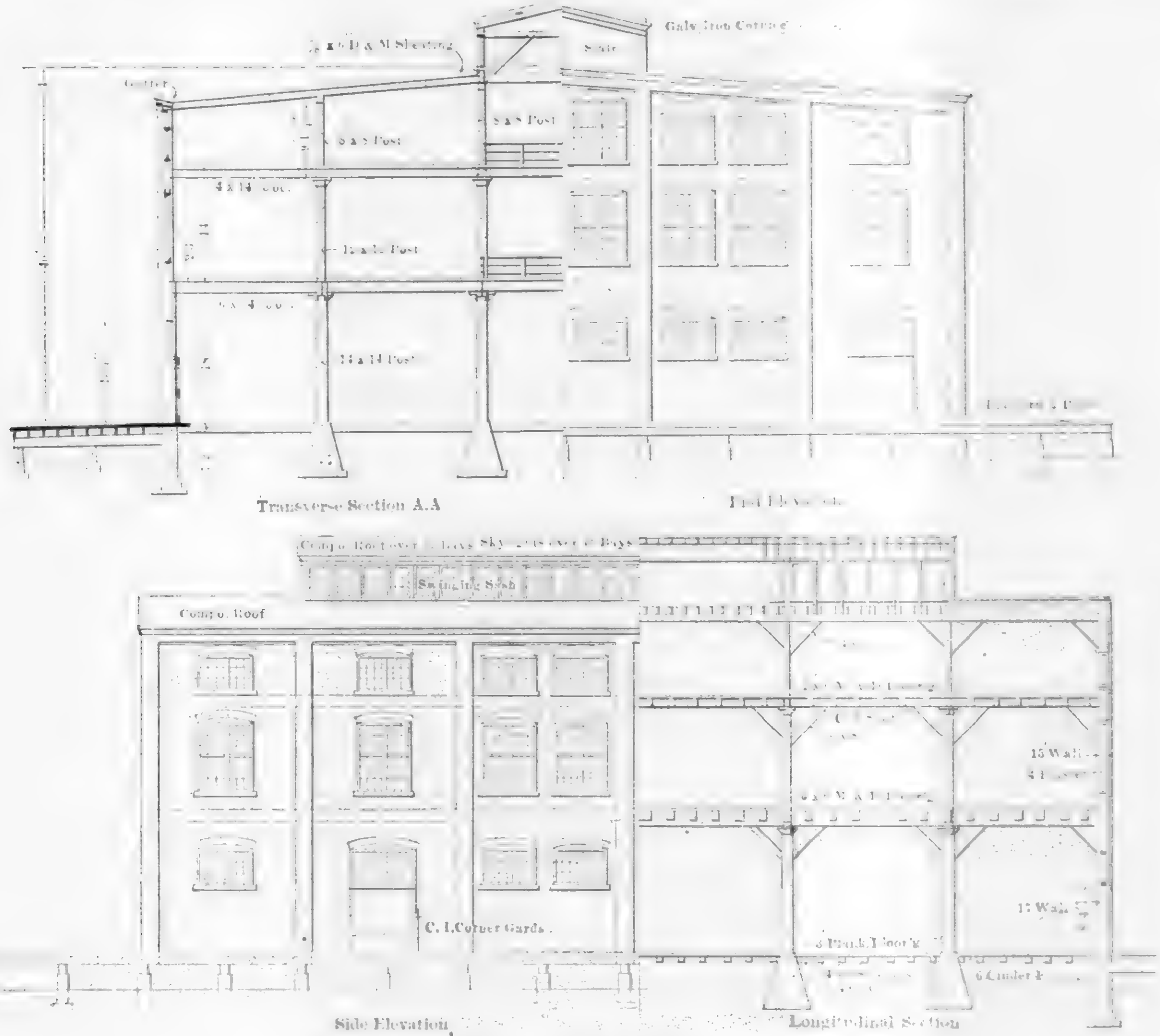

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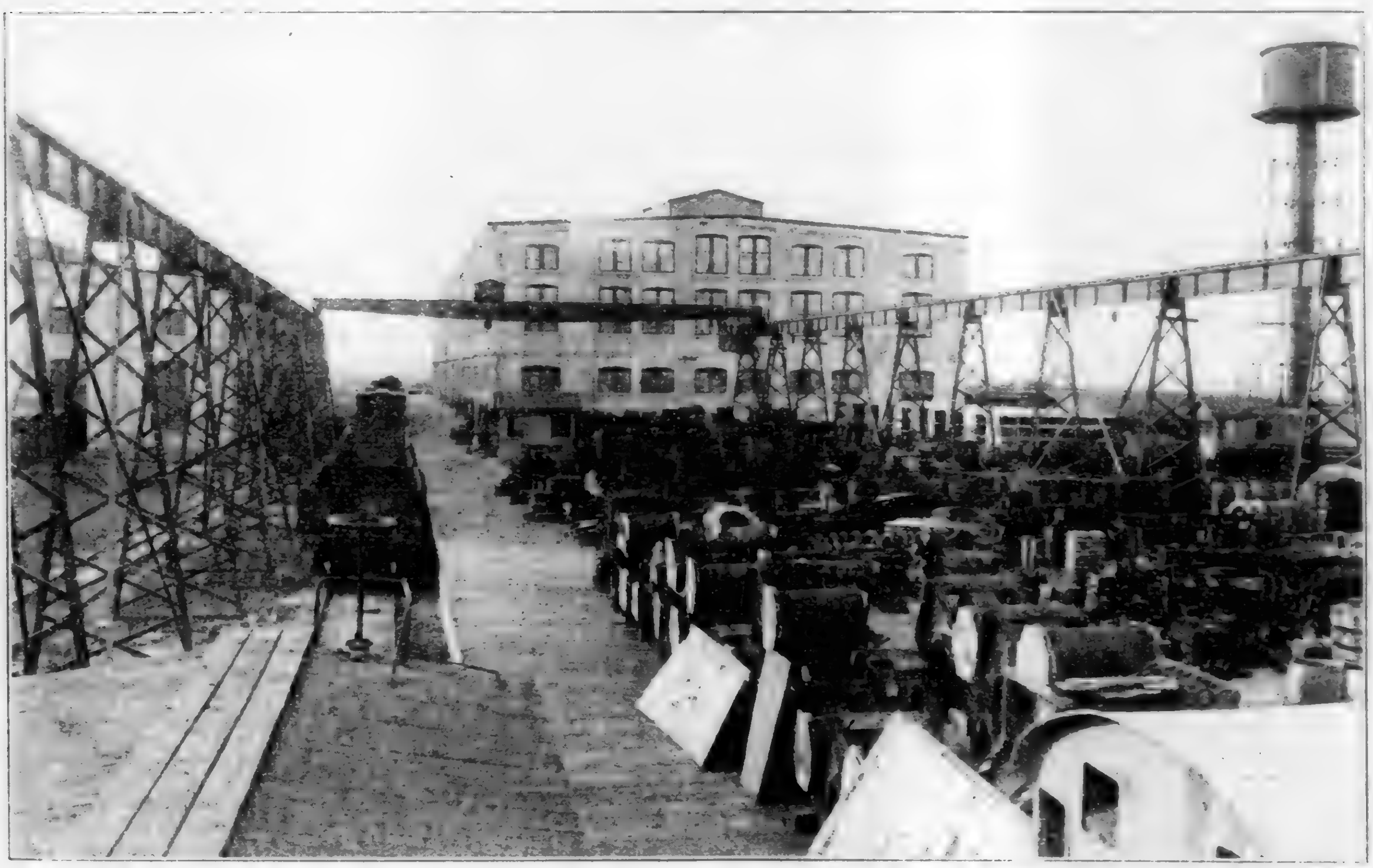


STOREHOUSE, STORAGE PLATFORM AND CRANE, WITH HIGH-SERVICE WATER TANK TO THE RIGHT.

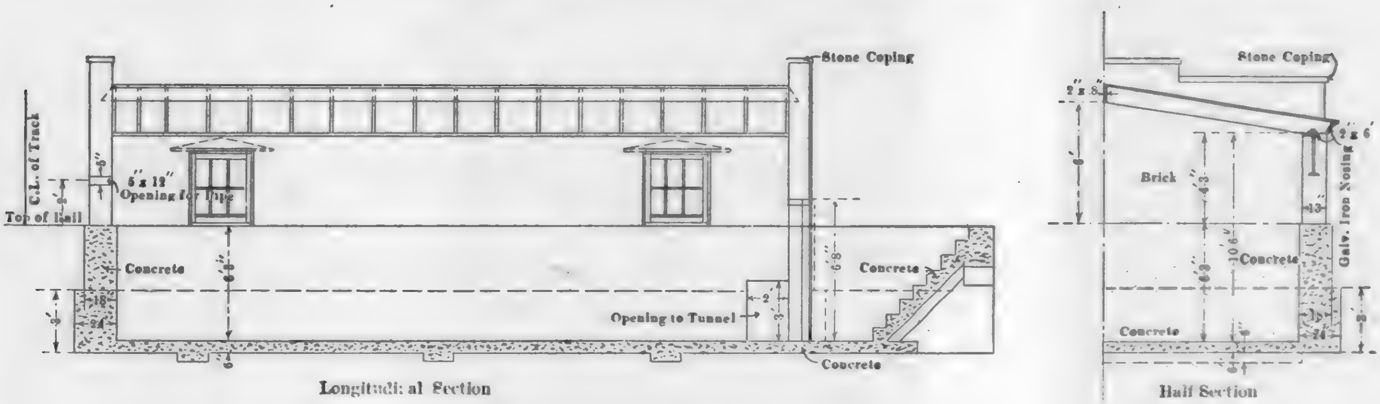
STOREHOUSE, LOOKING FROM THE WEST.

INTERIOR VIEW, SHOWING STOREHOUSE CONSTRUCTION.

SEWAGE DISPOSAL PLANT.

REFINED OIL HOUSE, LOOKING FROM THE SOUTH.

CRUDE OIL HOUSE, REFINED OIL HOUSE IN THE REAR.



SECTIONS OF THE CRUDE OIL HOUSE.

a shipping room directly over the storeroom in the basement, a barrel room, 60 ft. by 20 ft., and a waste room, 60 ft. by 28 ft. These rooms are entirely separate from one another and are steam heated. The building has four 30-in. galvanized iron globe ventilators.

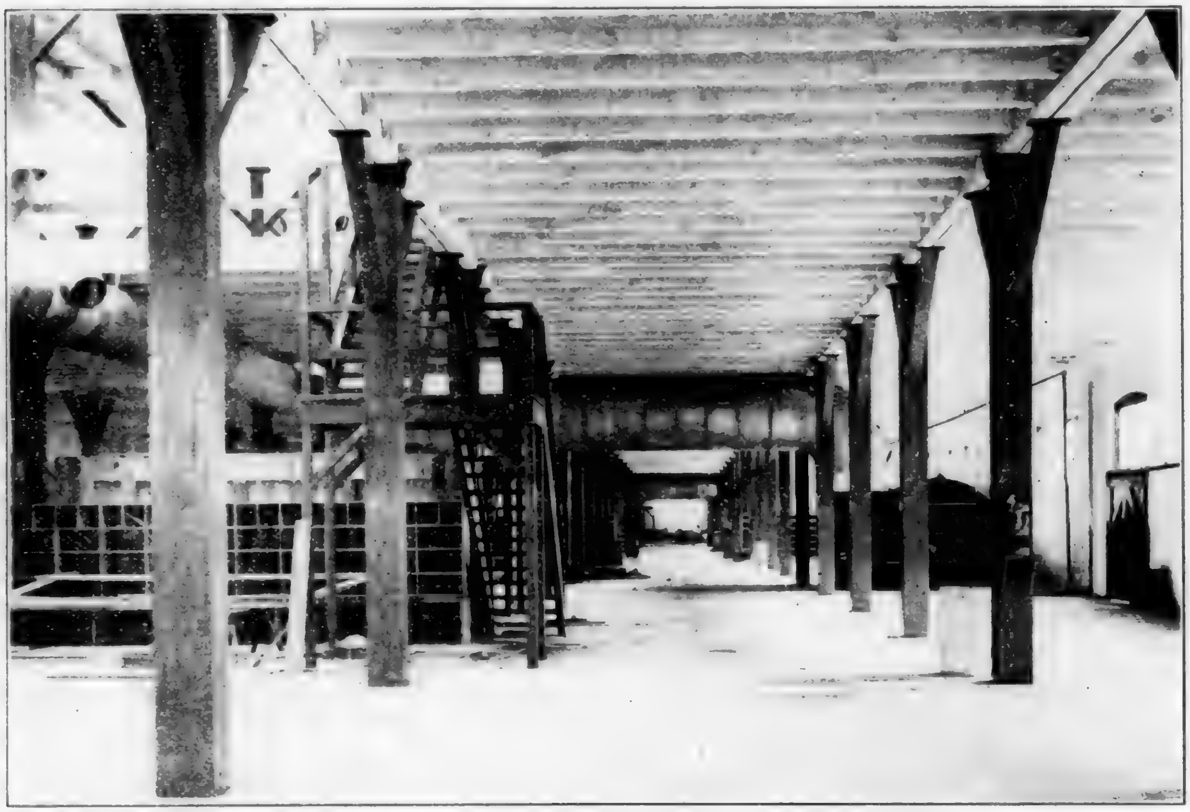
The crude oil house is eighty-nine feet south of the refined oil house and is 35 ft. by 21 ft. The floor is 6 ft. 3 in. below the surface of the ground; the footings, basement walls and floor are of concrete with cement-finished surface. Low brick walls form the superstructure. This house contains two 2,330-gallon tanks, and there is an air-tight manhole in the roof over each tank. Oil is forced from the tanks to a point where it is needed by compressed air. The roof has two 16-in. galvanized iron ventilators. The entrance door is at the east end of the building.

DRAINAGE SYSTEM.

All of the buildings are drained into a system of storm-water sewers, which also take care of the surface water in the immediate vicinity of the buildings. Because of the tunnel which connects the power house with the various buildings, it was necessary to design two systems, one draining off approximately one-half of the buildings to the east and north and the other the half to the west and north. Provision was made for a rainfall of two inches per hour. The sewers range from eight inches in diameter at their beginning to eighteen inches at the outlet, and their total length is 10,600 feet.

The sewage from the toilet rooms is carried in a separate sewer system to a sewage disposal plant. These sewers are six inches in diameter at the beginning, increasing to eight inches at the outlet, and their total length is about 4,700 feet. The sewage disposal plant consists of two septic tanks, with four filter beds for each tank. The tanks hold 35,000 gallons each, and when in full operation should be emptied every twenty-four hours. The filter beds are filled with locomotive front-end cinders, a 4-ft. bed overlaying a layer of twelve

STOREHOUSE, LOOKING FROM THE WEST.



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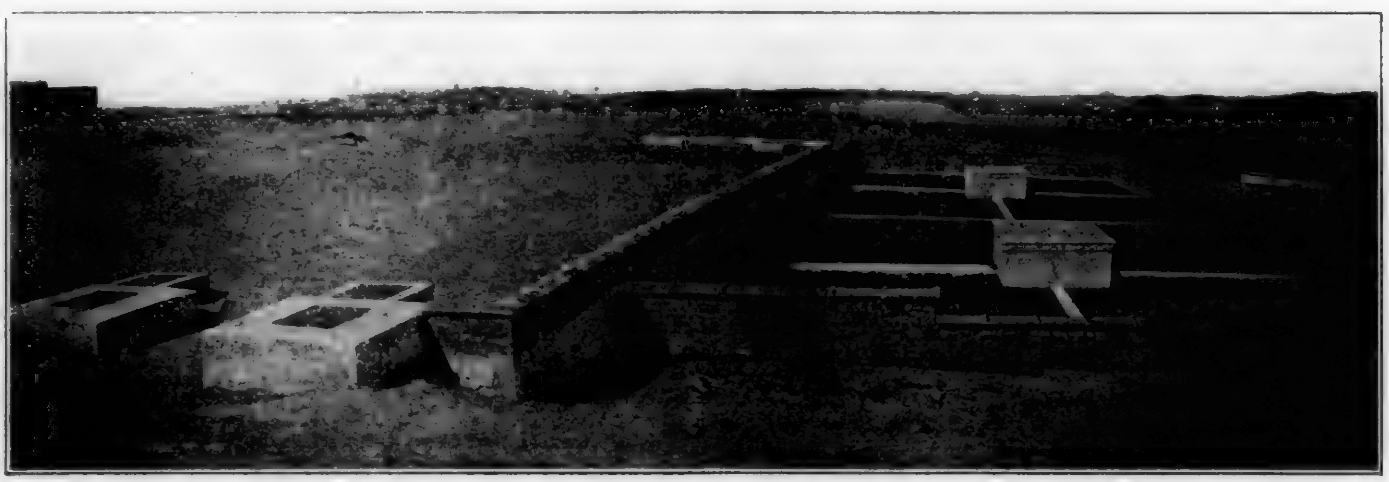

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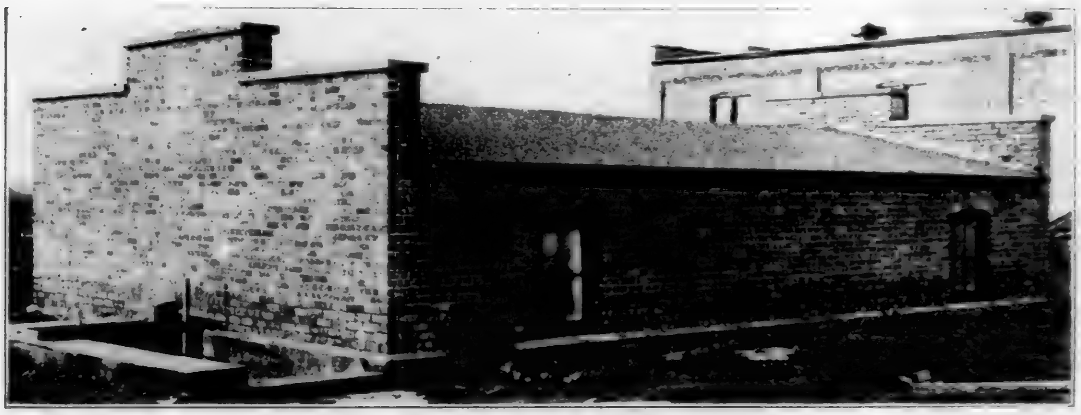
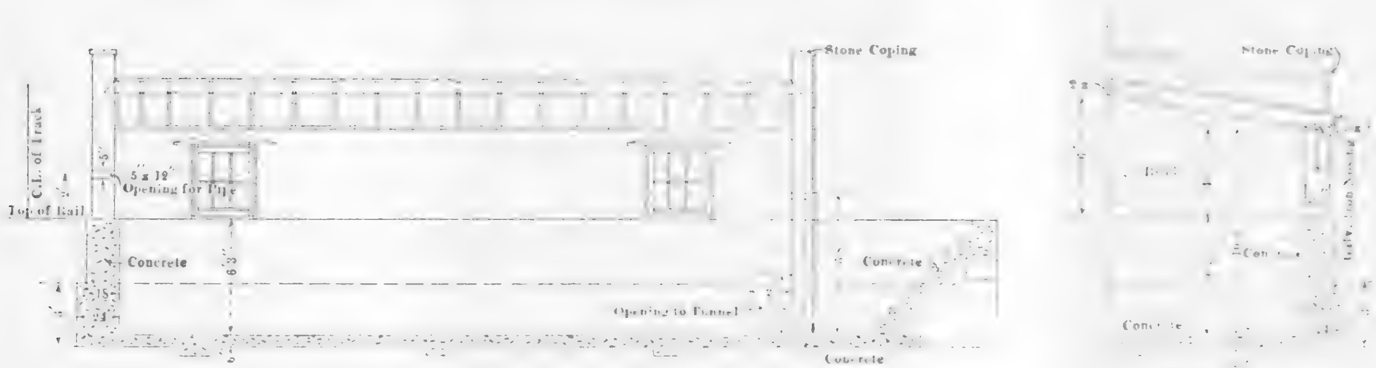


CRUDE OIL HOUSE, REFINED OIL HOUSE IN THE REAR.



Longitudinal Section

Half Section

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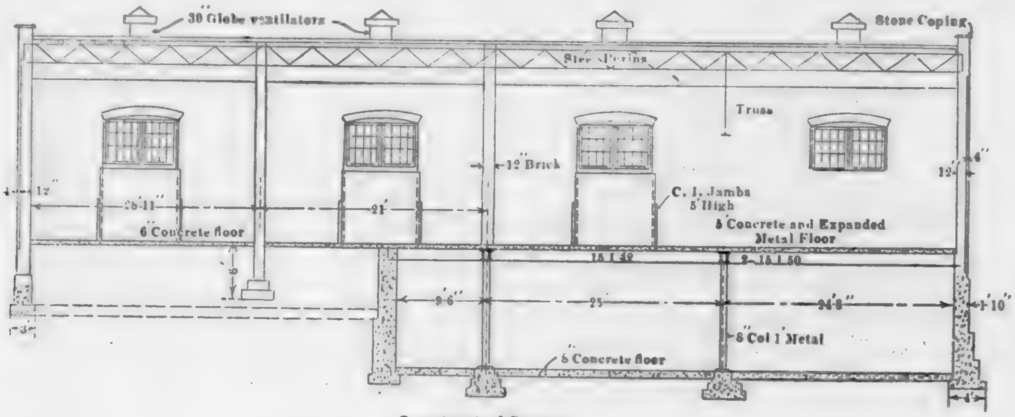


LONGITUDINAL SECTION OF THE REFINED OIL HOUSE.

inches of broken stone. They are each twenty-four feet square, each designed to be in service one-quarter of the time, and they are automatically cut in and out by a mechanism contained in a chamber four feet square at the intersection of each set of four filters.

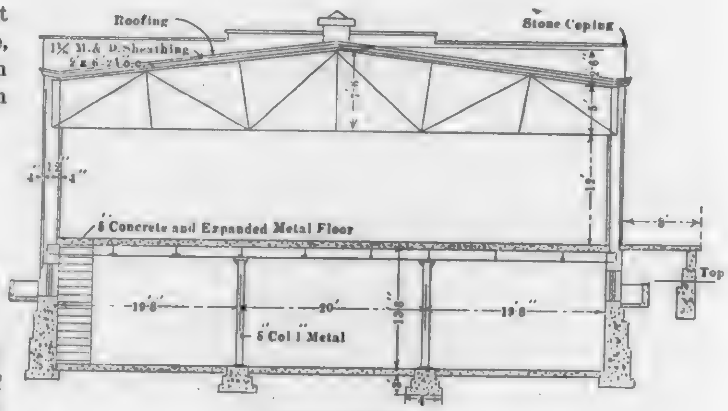
COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

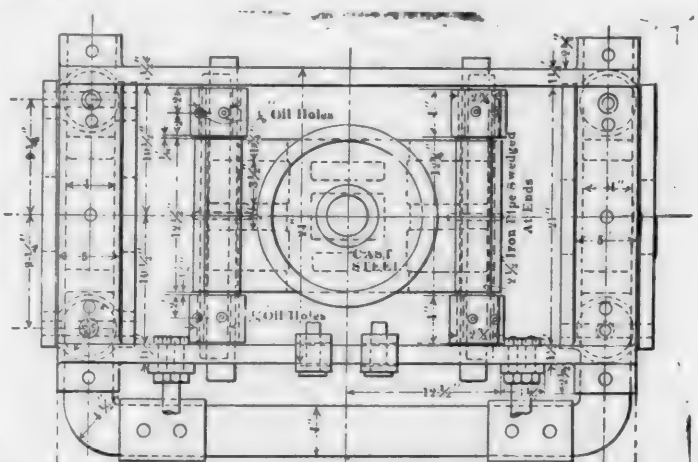
VII.

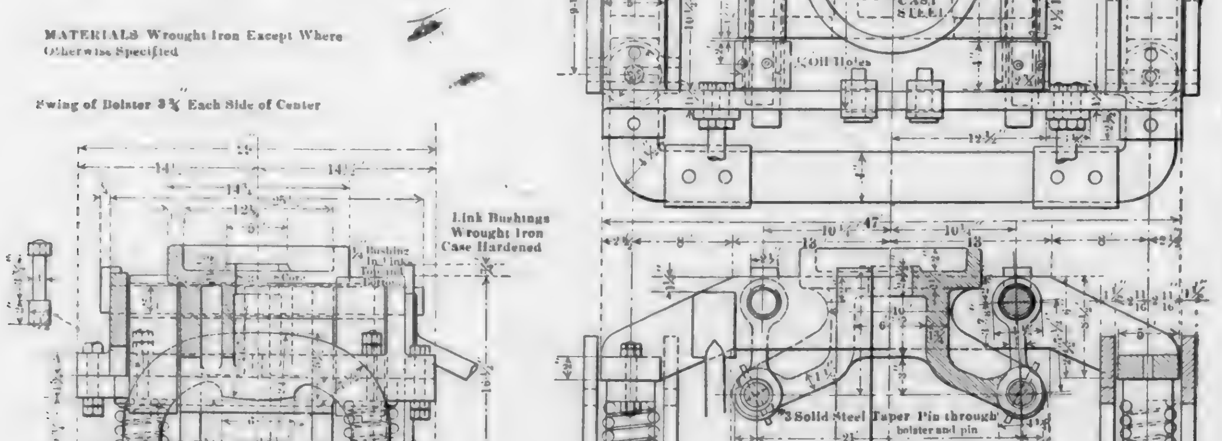
(For previous articles see pages 154, 200, 250, 288, 322 and 353.)

The accompanying illustrations show the construction of the leading and trailing trucks of the Atlantic, Pacific and consolidation classes. The trailing truck of the Atlantic type has inside journals without swing links and is not illustrated. The consolidation type has a cast steel swing bolster pony truck with wrought iron frame, without novelty in its construction. It is illustrated because it represents the standard construction for a very large number of freight locomotives. The journals of the truck wheels of all of the locomotives are 6 by 10 in.; the truck axles are standard throughout. The four-wheel leading truck for the Atlantic and Pacific type

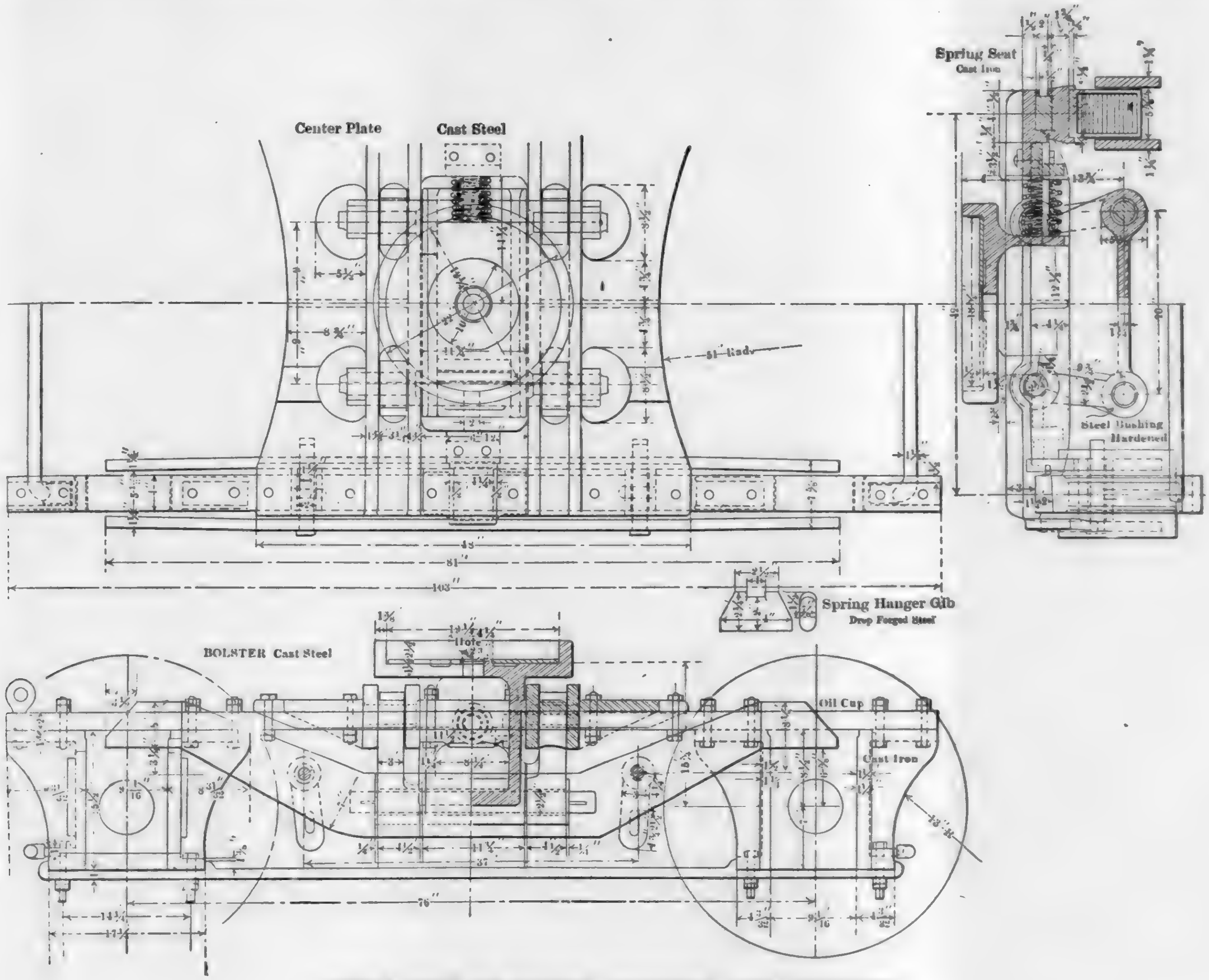


TRANSVERSE SECTION OF THE REFINED OIL HOUSE.

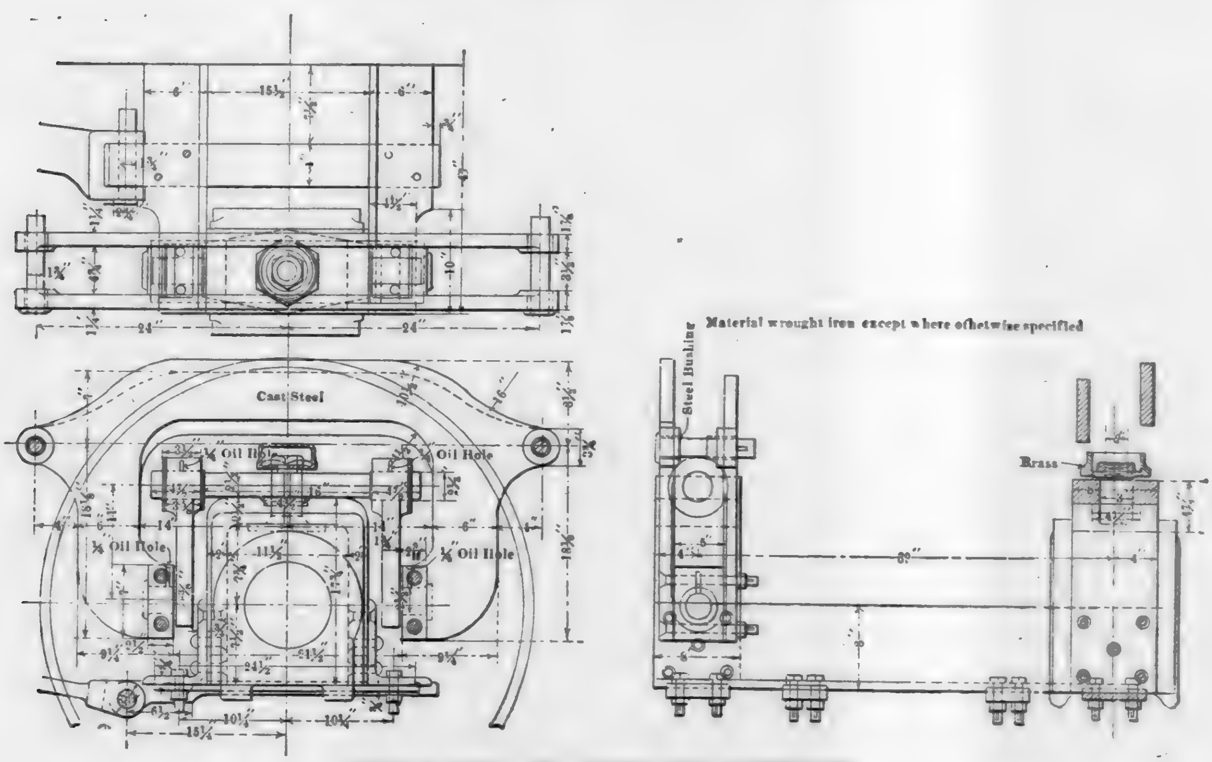




TRUCK FOR CONSOLIDATION LOCOMOTIVES—HARRIMAN LINES.



ENGINE TRUCK FOR ATLANTIC AND PACIFIC TYPE LOCOMOTIVES.



TRAILING TRUCK FOR PACIFIC TYPE LOCOMOTIVES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

locomotives employ swing links combined with a spring centering device, the construction of which is illustrated in the engraving. The saddle and swing bolster are of cast steel, otherwise this four-wheel truck does not employ construction which is at all unusual. The Rushton trailing truck for the Pacific type passenger locomotive is illustrated. This construction has been referred to before in these pages. The swing links are 11 ins. long between centers, and are loaded by the cast steel equalizers.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.

50-TON STEEL TWIN HOPPER GONDOLA CAR.

The Lake Shore & Michigan Southern Railway has just received from the American Car & Foundry Company 1,000 50-ton steel twin-hopper gondola cars, which are constructed almost entirely of structural steel, and are notable because of several radical departures from ordinary designs. The cars are designed to carry a load 20 per cent. in excess of their nominal capacity, and will carry fifty tons of ore loaded directly over the hopper doors. They are intended as a general utility car for carrying such materials as coal, coke, ore, pipe, pig iron, rails, structural material, etc. The door openings are large and unobstructed, so that coke may easily be unloaded through them. The sides and top of the car are made especially strong and stiff, so as to adapt it for use on unloading machines and for carrying heavy structural material loaded on the top of the sides. The rivets in the floor of the car are driven with a special flat head to avoid countersinking, and the floor plates are so arranged as to facilitate the handling of coal or ore with shovels. Special care was taken to arrange the inside of the car so that the entire load would be emptied when on the unloader, as it has been found that, with the ordinary construction, considerable coal or ore does not slide out. The general dimensions are as follows:

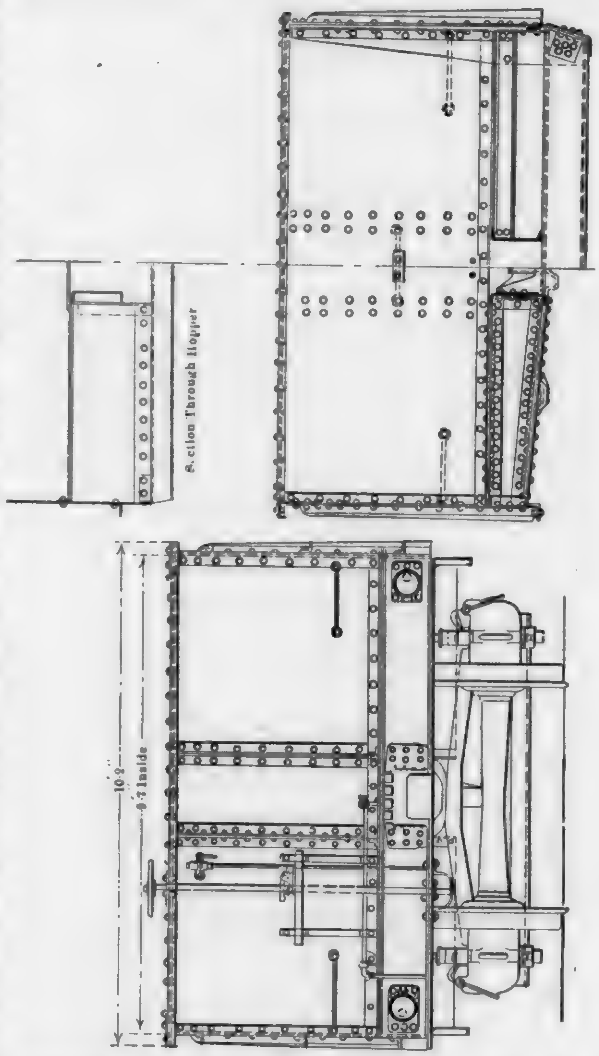
Length over end sills	38 ft.
Length inside	36 ft. 6 ins.
Width over sides	10 ft. 2 ins.
Width inside	9 ft. 7 ins.
Height inside	4 ft. 2 ins.
Height from top of rail to top of side	7 ft. 10¼ ins.
Height to lower face of center sills	2 ft. 8 ins.
Size of door openings	2 ft. 8½ ins. by 3 ft. 11⅞ ins.
Wheel base of trucks	5 ft. 5 ins.
Center to center of trucks	27 ft. 5 ins.
Weight of car	38,600 to 39,000 lbs.

The center sills are of 12-in. channels, 20.5 lbs. per ft., and extend through the body bolster and have 12-in. channel draft sills spliced to them. This splice is especially strong, as may be seen by referring to the detail drawing showing the application of the Westinghouse friction draft gear. Splice plates are placed on either side of each sill, the outer, or longer, plate taking the nine rivets, which hold the draft lug, while the draft lug itself butts up against the shorter inside splice plate, and thus prevents any tendency to buckle at this point.

The car is so designed that the center sills carry only a small proportion of the load. The load at the center of the car is transmitted to the side girders by means of the cross girder, consisting of two channels placed back to back. The details of the connection of this girder to the side sheets are unique. The gusset plate on the inside of the car passes down through the floor and between the members of the cross girder and is securely riveted to it. An inside plate, which is riveted to the lower part of the side sheet, passes down over the ends of the girder, is riveted to the bottom flanges of the girder channels and is also attached to the web of the channels by means of angles as shown.

Each side of the car is composed of four sheets, two of them extending from the bolsters to the ends of the car, so that they may be readily renewed in case of accident, and two extending from the bolster to the center of the car. The joint of the side sheets at the center of the car was very carefully designed, as the sides at this point are subjected to the most severe stresses, especially at their upper and lower edges. It will be noted that there is a splice plate on the inside and that the side stiffener fulfills this function on the outside.

Attention is directed to the channel at the top of the side and end sheets, which adds greatly to their stiffness sidewise and to the strength of the side girders. In addition to the gusset plates at the middle there are four other gussets on each side of the car. The sides are stiffened opposite each hopper door by pressed steel siffeners placed horizontally on the inside of the car, the angle of the projection on these stiffeners being such that coal or ore will readily slide off of it. It will be seen from the drawing showing the arrangement of the drop doors that the hopper sheet is riveted to the top of the center sill and passes down over it in such a way that it is impossible for any of the lading to lodge in the channels. Each end sheet is stiffened by the two gussets on the outside.

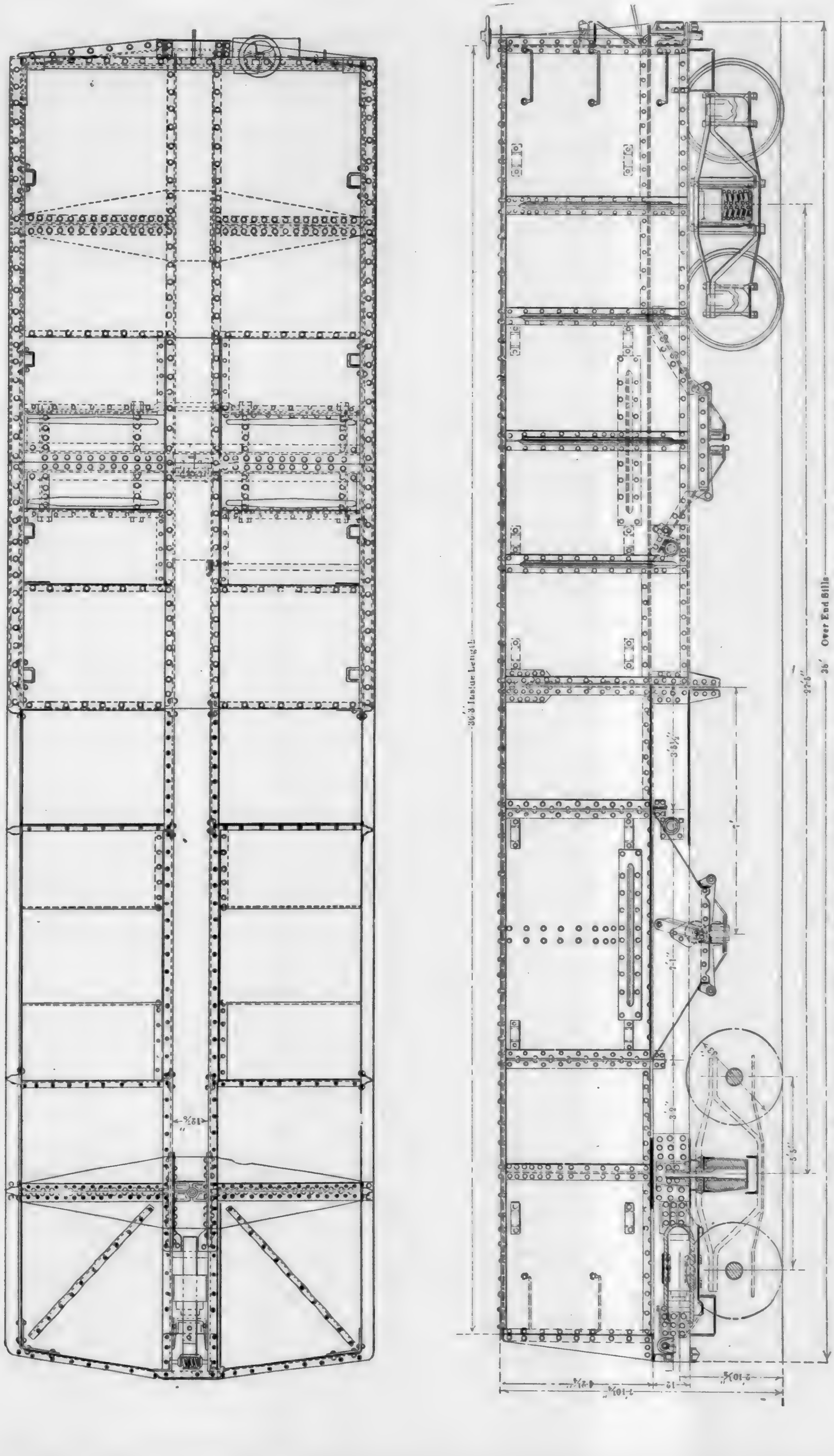


CROSS-SECTIONS. END VIEW.
50-TON STEEL TWIN HOPPER GONDOLA CAR.

Referring to the plan view it will be seen that the end sill is not straight, but slopes back from the center so that there will be no opportunity for the corners of the cars crushing each other on sharp curves. The floor plates are turned upwards at the sides and are riveted to the side sheets. Floor stiffeners, consisting of light channels, extend across the car at proper intervals and also diagonally across at each corner.

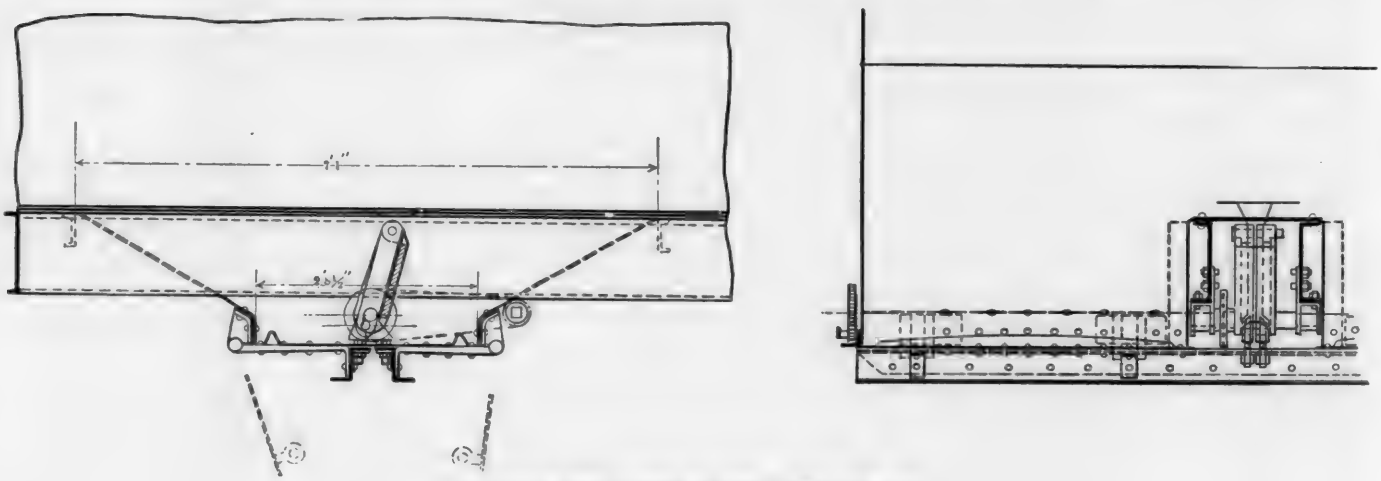
At the body bolster a filler casting is used between the center sills, and the bolster from the center to the side sill consists of a plate with angles riveted at both the top and bottom, and this is reinforced by heavy top and bottom cover plates which extend the full width of the car, the bottom cover plate passing down underneath the side and being riveted to the angle which forms the bottom member of the side girder.

The hopper doors are operated by the Dunham type drop-door mechanism, made by the United States Metal & Manufacturing

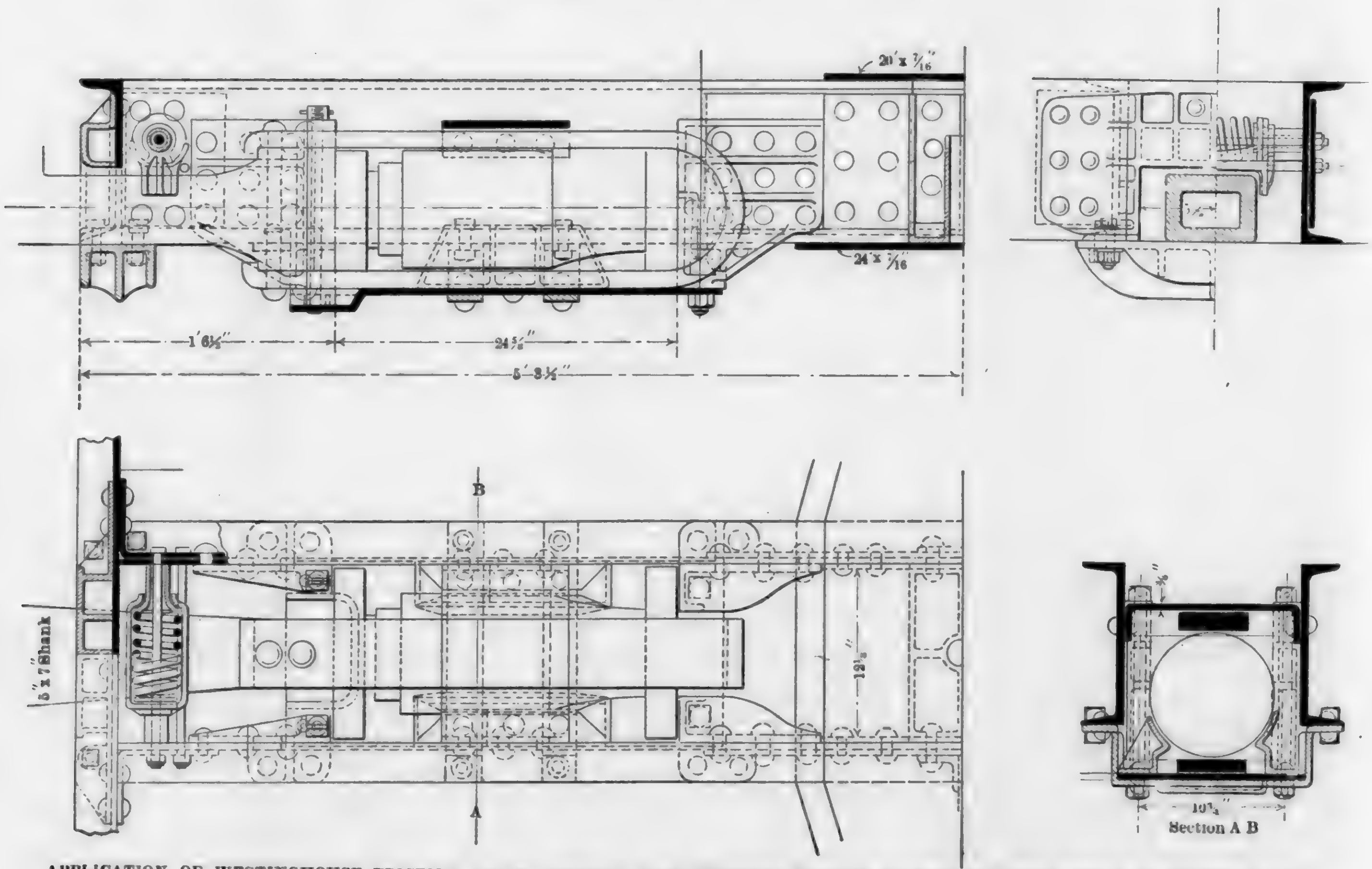


PLAN AND SIDE ELEVATION OF 50-TON STEEL TWIN HOPPER GONDOLA CAR.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

50-TON STEEL TWIN HOPPER GONDOLA CAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



DROP-DOOR MECHANISM—50-TON GONDOLA CAR.



APPLICATION OF WESTINGHOUSE FRICTION DRAFT RIGGING; ALSO SHOWING METHOD OF SPLICING DRAFT SILLS TO CENTER SILLS—50-TON GONDOLA CAR.

Company. This device is very simple and is positive locking. The chain is used merely to close the doors, which it does by operating the crank, and when the crank center is once past the center of the doors all load is taken off the chain and the load of the doors tends to throw the crank center farther to the right, but this is impossible because of the construction of the crank casting, as may be seen by reference to the drawing. The chain is also used to throw the crank to the left and thus open the doors. The wrench which operates the shaft upon which the chain sprocket is keyed is so designed that when the crank center passes to the left of the center of the doors and the load causes the doors to open with considerable force, the wrench slips off the end of the shaft and the operator is not liable to injury. As the center of the doors is not coincident with the center of the crank it is necessary to use a longer hanger for one of the doors, and this causes one door to close before the other, and when both of the doors are completely closed one of them forms a "ship lap" over the other. It will also be noticed that the doors close up tightly under the hopper opening and that there are no flanges on them which fit up into the opening and cause the doors to get out of order if the car gets out of alignment.

The doors are stiffened by Z bars, which are reinforced by the bent plates, and extend the full width of both doors, and also by the projection which is pressed in the upper side of the door near its edge. The edges of the hopper opening are reinforced by the bent plates which extend crosswise. The door hangers are of flanged steel.

A simple, efficient and substantial centering device, made by the United States Metal & Manufacturing Company, centers the coupler and provides for an excess amount of side play, thus relieving the strains on the underframe and on the coupler and its component parts when on curves, and it also reduces wheel-flange wear and strain on the trucks and greatly simplifies the matter of coupling on curves.

Except for the journal and pedestal bolts for the Simplex trucks, which are fitted with double nuts, these cars are equipped throughout with Columbia lock nuts, which, for this class of work, are considered equivalent to rivets, except that, if necessary, the nuts may readily be removed. We are indebted for information and drawings to Mr. H. F. Ball, superintendent of motive power of the Lake Shore & Michigan Southern Railway, and to the American Car & Foundry Company.

FLUES WITH REDUCED FIREBOX ENDS.

By Don Sweney.

Reducing the firebox end of locomotive boiler flues to about ⅛ inch less than the nominal diameter for a distance of about eight inches from the flue-sheet has been practiced to a limited extent, but does not seem to come into much favor, nor does any definite conclusion seem to be arrived at as to the value of such a practice. In my acquaintance with the subject it seems to me it has always been presented wrong, argued and discussed on the wrong assumptions and experiments made with the wrong end in view. Advocates of reduced-end flues explain that with 2-inch flues spaced 2 11/16 in. between centers and so having the usual 11/16 in. space between them, the flues can be reduced to 1⅞ in. diameter at the firebox end for a short distance—6 or 8 in.—and thereby obtain 13/16 in. flue-sheet bridges and circulating space between the flues at the point where the generation of steam is very rapid and circulating space most needed. A trial of such flues many not show the advantage expected, or it may not be possible to detect the advantage if it does exist, and this practice therefore stands, like some other practices or designs, on its theoretical merit. The fact of the matter is, that under the circumstances which the reduced-end flues are tried and not found to be of any value the wider space obtained between the flues is not needed, and therefore gives no appreciable benefit over the regular space obtained between the full-sized ends.

It is still true, however, that more space is needed between the flues near the back flue-sheet than is required farther ahead in the boiler, and that if 11/16 in. space between the flues at and near the flue-sheet is sufficient, 9/16 in. space is undoubtedly sufficient for the remainder of the flue length. Therefore the 2-in. flues with 1⅞ in. back ends might be spaced 2 9/16 in. between centers, giving the required 11/16 in. space between the flues at and near the back flue-sheet where it is needed, and 9/16 in. space between the flues for the remainder of the length where that spacing is sufficient. The fact that the steam evaporated from the flue-sheet, as well as that from the first 2 or 3 in. of the flues, must pass up between the flues in about that portion of their length, and that the evaporation per square inch from the back end of the flues is the greatest, decreasing in each consecutive portion of the length toward the front in about the same proportion that steam pressure decreases by expansion, it seems that a reduction of the back ends of the flues for a distance of about 6 or 8 in. ought to be sufficient.

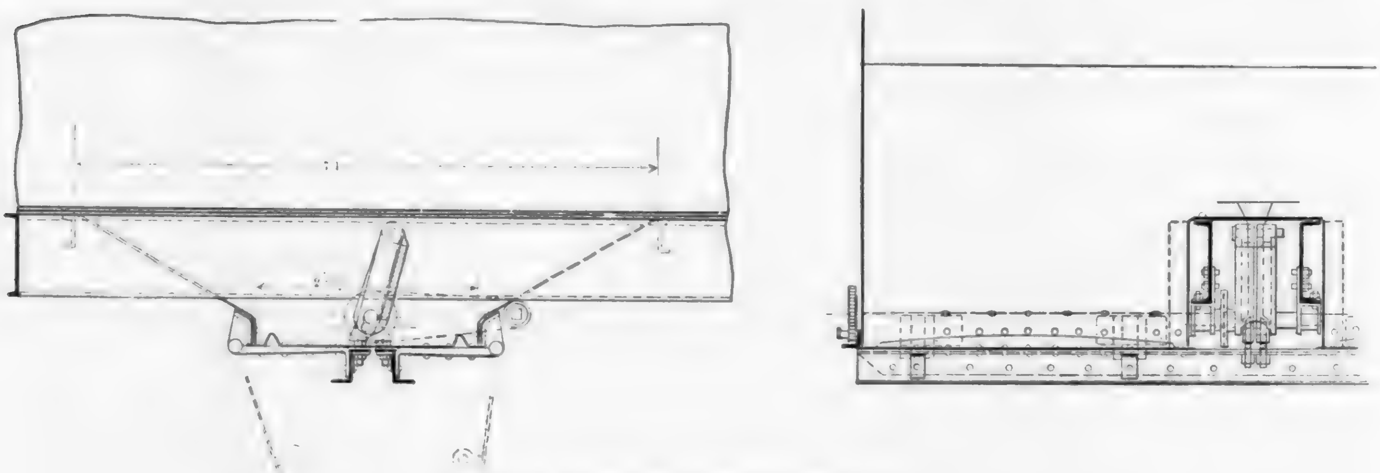
With 2-in. flues having the back ends reduced to 1⅞ in. and compared with the same size flues spaced the same distance between centers, but having full-sized ends, the circulating space near the back flue-sheet and the back flue-sheet bridges is increased about 19 per cent., the draft area of entrance to the flues is decreased about 13.8 per cent. and the draft resistance due to entrance to and exit from the flues is increased about 6.9 per cent., the draft resistance due to friction of the gas passing through the flues remains the same and the heating surface and flue volume remain about the same; therefore, if there is no requirement for the wide bridges and circulating space, this form of flue end with this spacing is a disadvantage to the extent which it obstructs the draft.

With 2-in. flues having the back ends reduced to 1⅞ in. diameter and spaced ⅛ in. less between centers than flues having full-sized ends and compared with 2-in. flues having full-sized ends and the regular spacing, the width of the back flue-sheet bridges and the circulating space near the back flue-sheet remain the same, the number of flues is increased 10 per cent., with a consequent increase of heating surface and flue volume, the draft area of entrance to the flues is decreased about 5 per cent. and of exit increased 10 per cent., whereby the draft resistance due to entrance to and exit from the flues is reduced about 2½ per cent., and the draft resistance due to friction of the gas passing through the flues is reduced about 10 per cent.

The possibility of gaining 10 per cent. effective heating surface and flue volume in a boiler, with no more additional weight than that of the flues added ought to make this design of flue ends and flue spacing a valuable feature of boiler design.

Shop Foremen.—There is one thing that I wish to lay particular stress on, and that is the matter of supervision. I doubt if any of the railroad shops in this country have too many foremen; there are certainly many shops which have not enough foremen. It is not economical to require much clerical work of a foreman, for almost any foreman can waste the monthly salary of a clerk every day in the week if he is tied down at a desk. The difference between good and poor foremen is also often underrated, and it is not uncommon for a railroad company to allow a good foreman to leave rather than pay him a few dollars more a month or to retain a poor foreman simply because they think he is cheap. The wastefulness of poor foremen is not generally realized. I know one case where a foreman was not satisfactory, and the management was advised that $500 a month could be saved by putting in an efficient and up-to-date man. This finally was done, and within 90 days after the change the new man had saved $1,300 a month in labor alone and was producing more and better work than his predecessor.—*Mr. M. K. Barnum, before the Western Railway Club.*

50-TON STEEL TWIN HOPPER GONDOLA CAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



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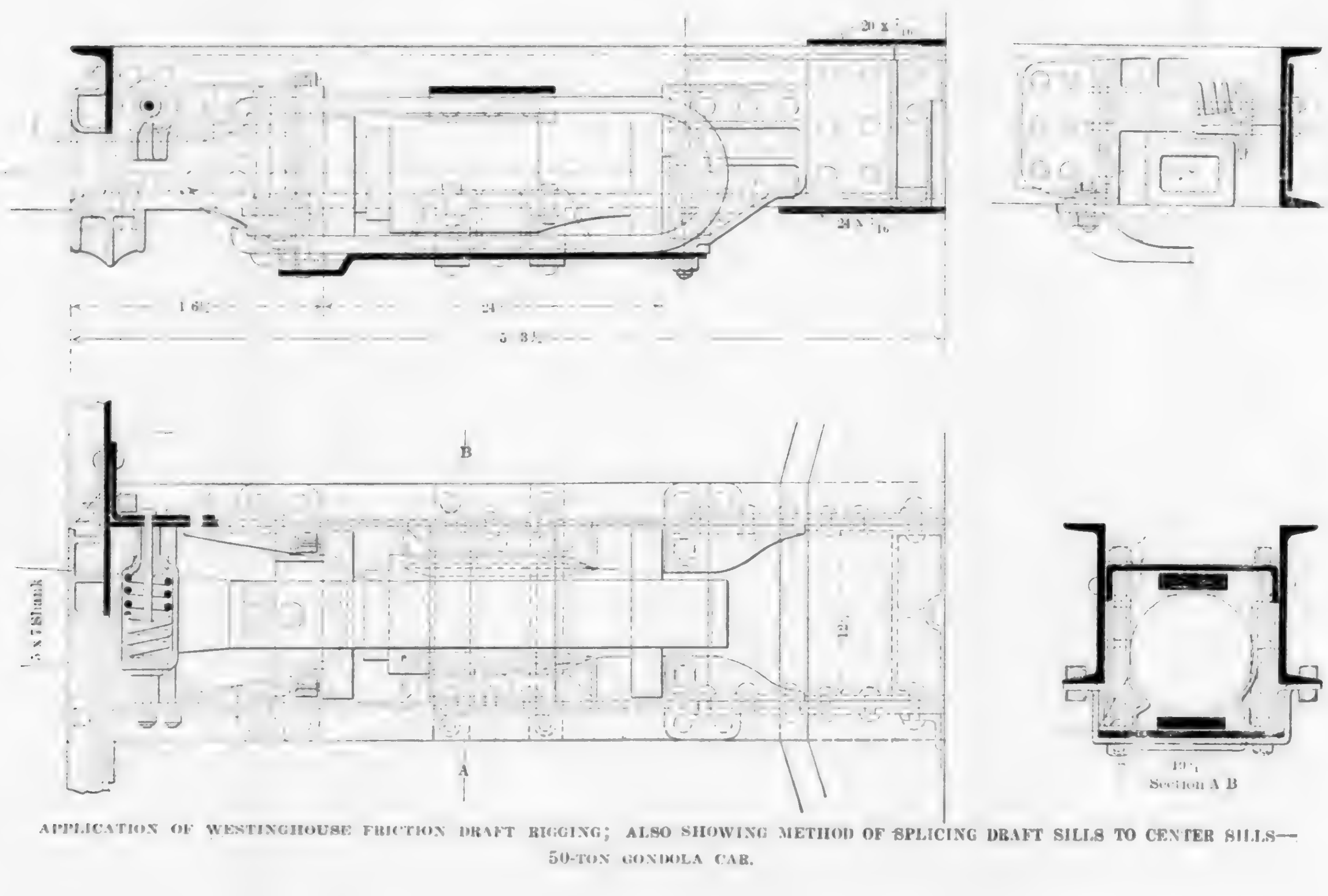

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PRODUCTION IMPROVEMENTS.

Milling Cast Steel Driving Boxes.

For some time past it has been the practice at the Angus shops of the Canadian Pacific Railway to machine driving boxes for new equipment on a slab milling machine instead of a planer. The sides of the boxes are milled with a high-speed steel inserted tooth cutter, 8 in. in diameter and 30 in. long, as shown in Fig. 1. The machine is a heavy motor-driven, 48-in. Bement-Miles & Company horizontal miller. On cast steel a cut ½ in. deep, with a feed of 1⅜ in. per minute may be taken at a speed of 30 r.p.m. With lighter cuts the feed may be increased. Twelve driving boxes (two rows of six each) are placed on the machine at one time. Because of the roughness of the cast steel boxes, more time is required to set them up than for cast iron. As many as 20 cast steel boxes, for 9 and 9½ in. journals, have been machined on both sides in a day of ten hours, and 30 cast iron boxes for 8½ in. journals have been machined in ten hours.

The shop has only one of these 30-in. milling cutters, and this has been in use for the past twelve months, and in that time has machined all the driving boxes for the following new equipment: 25 6-wheel switch (cast iron boxes), 25 10-wheel freight (cast steel boxes) and 6 Pacific type passenger engines (cast steel boxes), and in addition to this it has been used on some repair work. While the cutter is worn considerably, it is still good for another lot of at least 25 new engines. This cutter has been used largely as an experiment and was probably abused to some extent before the most suitable feeds and speeds for different materials and the proper methods of lubrication were determined upon, and therefore a second cutter will undoubtedly last longer. Some little experimental work was also required to determine the length of time which the cutter should be run before regrinding. A cutter of this kind can satisfactorily mill 42 cast steel boxes (84 sides) before regrinding, although these boxes are rough, sandy and uneven.

It has been found that in milling cast steel it is very important that a good stream of soda or compound be forced onto the cutter, and the suggestion is made that milling machines to handle this class of work should be provided with a large capacity pump and have a comparatively large reservoir on top of the housing. Two pipes could run down from the reservoir to the cutter and each one end in a T with a large number of small holes in it, so that a good stream of lubricant could be forced onto the cutter over its entire length.

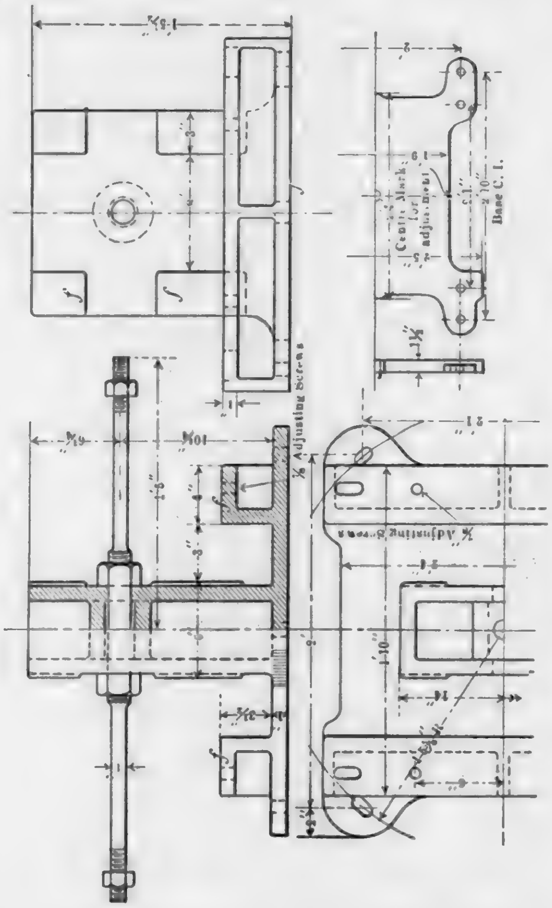


FIG. 3—JIG FOR HOLDING DRIVING BOXES WHILE MILLING THE SHOE AND WEDGE FITS.

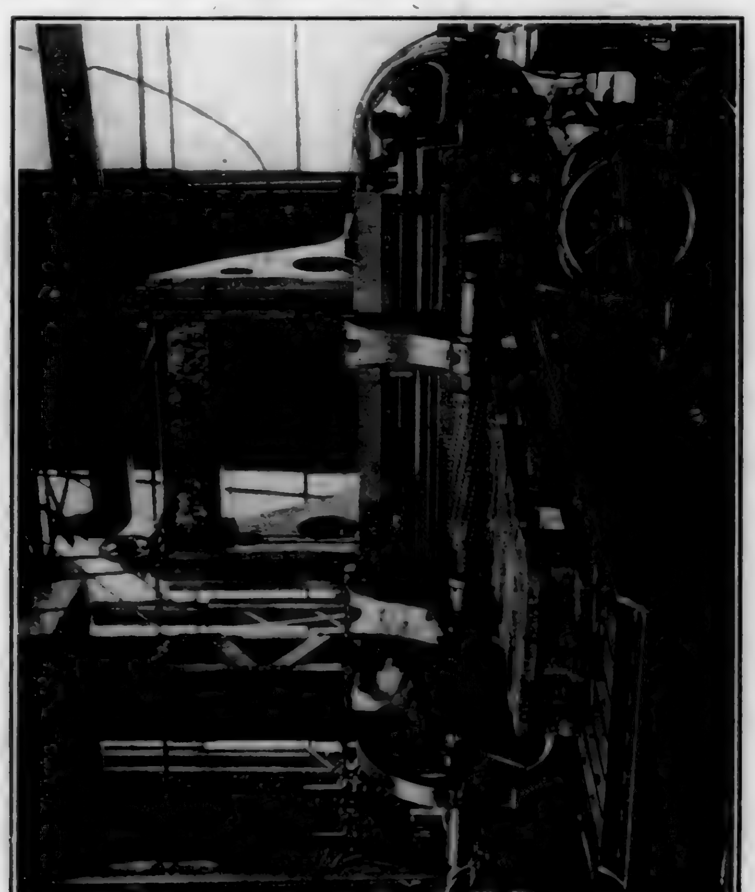


FIG. 1—MILLING THE SIDES OF THE DRIVING BOXES.

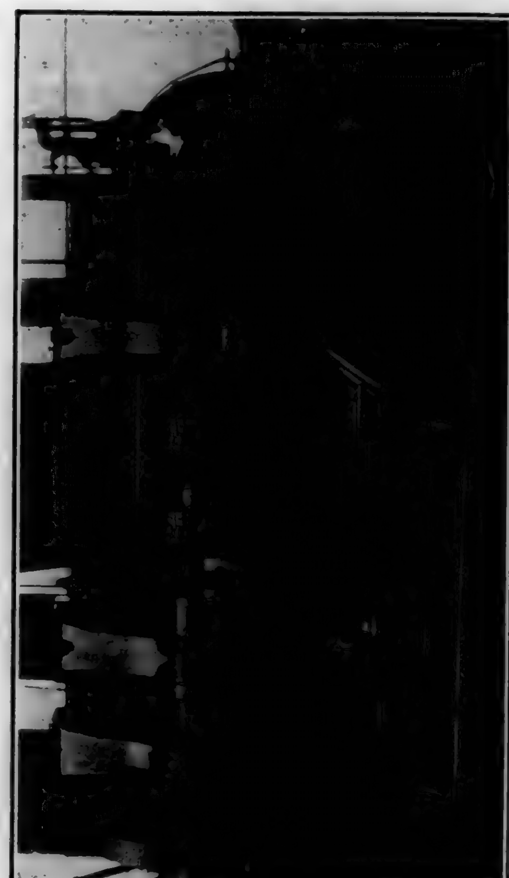


FIG. 2—MILLING THE SHOE AND WEDGE FITS.

Fig. 2 shows the method of milling these boxes for the shoe and wedge fits. The cutters are 12 in. in diameter of the high-speed steel inserted plate type. It will be seen that each tool is made in two pieces, and that the cutters overlap each other. It is thus possible to vary the width of the cutters and thus keep them up to standard size. These cutters will mill about 30 boxes without regrinding. In cutting cast iron they run at 12 r.p.m. and feed at the rate of 1⅜ ins. per min., while in cutting cast steel they may be run at 15 r.p.m. with a ⅝-in. feed per min. Fig. 3 shows in detail the jig for holding these boxes. The base plate of the jig is bolted to the table of the miller, and the jig is pivoted on this plate and may be set at any desired angle. The jig holds two boxes, which are clamped to its side by means of a long stud, and the box is adjusted for height by means of the two adjusting screws, and is clamped at both the front and back. One man will mill the shoe and wedge fit for at least 12 cast iron boxes (8½ to 9½-in. journals) in a day of 10 hours or 8 cast steel boxes of the same size. We are indebted for this information to Mr. H. H. Vaughan, superintendent of motive power; Mr. H. Osborne, superintendent of shops, and Mr. Gustave Giroux, piece work inspector.

10-WHEEL PASSENGER LOCOMOTIVE.

DELAWARE, LACKAWANNA & WESTERN RAILROAD.

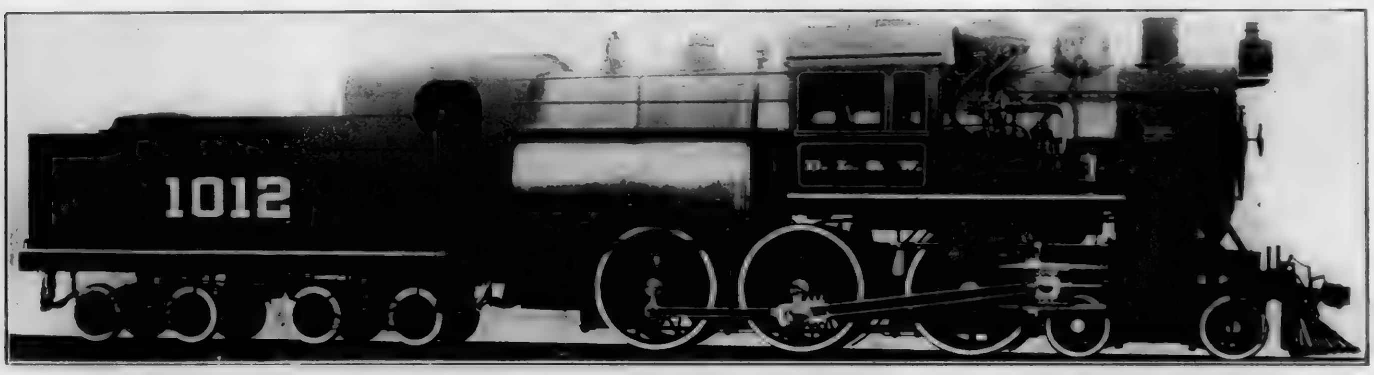
The Delaware, Lackawanna & Western Railroad has just received from the Schenectady works of the American Locomotive Company five 10-wheel passenger locomotives, which are the most powerful locomotives of this type ever built for passenger service. They have a tractive power of 35,100 lbs., 22½ by 26-in. cylinders, a total weight of 201,000 lbs., and carry a boiler pressure of 215 lbs. The driving wheels are 69 ins. in diameter, and, although rather small for a 10-wheel passenger engine, are large for a locomotive of this type with a broad firebox. The driving wheels are the same size as those used on the 4—4—0 type engines on this road. This is the heaviest passenger engine of this type, being 2,000 lbs. heavier than similar engines built for the Lehigh Valley Railroad, which have a tractive power of 31,380 lbs., 21 x 28-in. cylinders, 68½-in. driving wheels, a total weight of 199,200 lbs., weight on drivers 150,200 lbs., and carry 205 lbs. steam pressure.

The only passenger engines more powerful than these, of which we have a record, are the 22 x 28-in. Pacific type locomotives built for the Southern Railway, which have a tractive power of 35,194 lbs., a total weight of 218,950 lbs., weight on drivers 141,650 lbs., 72-in. drivers, and carry 220 lbs. of steam.

The Prairie type locomotives used for freight and passenger service on the Chicago, Burlington & Quincy Railroad, described on page 78 of our March, 1905, issue, have a tractive power of 35,050 lbs., or a little less than that of the Lackawanna engines. Considering the tractive power, the total weight of the Lackawanna engine is remarkable low. The leading dimensions are as follows:

4—6—0 TYPE PASSENGER LOCOMOTIVE, DELAWARE, LACKAWANA & WESTERN RAILROAD.

GENERAL DATA.	
Gauge	4 ft, 8½ ins.
Service	Passenger
Fuel	Fine Anthracite
Tractive Power	35,100 lbs.
Weight in working order	201,000 lbs.
Weight on drivers	154,000 lbs.
Weight on leading truck	47,000 lbs.
Weight of engine and tender in working order	321,000 lbs.
Wheel base, driving	14 ft., 4 in.
Wheel base, total	25 ft. 6 ins.
Wheel base, engine and tender	54 ft. ¼ in.
RATIOS.	
Tractive weight ÷ tractive effort	4.38
Tractive effort x diam. drivers ÷ heating surface	717.
Heating surface ÷ grate area	35.6
Total weight ÷ tractive effort	5.72
CYLINDERS.	
Kind	Simple
Diameter and stroke	22½ ins. x 26 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	Allen Richardson balanced
Greatest travel	5½ ins.
Steam lap	1 in.
Setting 1-16 in. lead in full gear forward and shift backup eccentrics to give ¼ in. lead at 6 ins. cut-off, forward motion.	
WHEELS.	
Driving, diameter over tires	69 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 13 ins.
Driving journals, others, diameter and length	9½ x 13 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6½ x 12 ins.
BOILER.	
Style	Straight top
Working pressure	215 lbs.
Outside diameter of first ring	74⅝ ins.
Firebox, length and width	126⅛ ins. x 108¼ ins.
Firebox plates, thickness	⅜ and ½ ins.
Firebox, water space	4 ins.
Tubes, number and outside diameter	398 2-in.
Tubes, gauge and length	12, 15 ft. 3 ins.
Heating surface, tubes	3,156.3 sq. ft.
Heating surface, firebox	221.7 sq. ft.
Heating surface, total	3,378.0 sq. ft.
Grate area	94.8 sq. ft.
Exhaust pipe—Double nozzles	3½ and 3⅝ ins.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 9-16 in.
Centre of boiler above rail	116½ ins.
TENDER.	
Tank	U shaped with hood at front, D., L. & W. std.
Frame	10-in. channels and plates
Weight, loaded	120,000 lbs.
Wheels, diameter	33 ins.
Journals, diameter and length	5 x 9 ins.
Water capacity	6,000 gals.
Coal capacity	10 tons



10-WHEEL (4—6—0 TYPE) PASSENGER LOCOMOTIVE—DELAWARE, LACKAWANNA & WESTERN RAILROAD.

SHOP COSTS.—Another advantage to be gained by close knowledge of shop costs is this—it enables the foreman to intelligently ask for improved facilities. All general officers are willing to indorse requests for appropriations provided a saving can be shown equal to an amount representing a fair return on the investment.—*Mr. J. H. Wynne, before the Western Railway Club.*

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PRODUCTION IMPROVEMENTS.

Milling Cast Steel Driving Boxes.

For some time past it has been the practice at the Angus shops of the Canadian Pacific Railway to machine driving boxes for new equipment on a slab milling machine instead of a planer. The sides of the boxes are milled with a high-speed steel inserted tooth cutter, 8 in. in diameter and 30 in. long, as shown in Fig. 1. The machine is a heavy motor-driven, 48-in. Bement-Miles & Company horizontal miller. On cast steel a cut ½ in. deep, with a feed of 1⅜ in. per minute may be taken at a speed of 30 r.p.m. With lighter cuts the feed may be increased. Twelve driving boxes (two rows of six each) are placed on the machine at one time. Because of the roughness of the cast steel boxes, more time is required to set them up than for cast iron. As many as 20 cast steel boxes, for 9 and 9½ in. journals, have been machined on both sides in a day of ten hours, and 30 cast iron boxes for 8½ in. journals have been machined in ten hours.

The shop has only one of these 30-in. milling cutters, and this has been in use for the past twelve months, and in that time has machined all the driving boxes for the following new equipment: 25 6-wheel switch (cast iron boxes), 25 10-wheel freight (cast steel boxes) and 6 Pacific type passenger engines (cast steel boxes), and in addition to this it has been used on some repair work. While the cutter is worn considerably, it is still good for another lot of at least 25 new engines. This cutter has been used largely as an experiment and was probably abused to some extent before the most suitable feeds and speeds for different materials and the proper methods of lubrication were determined upon, and therefore a second cutter will undoubtedly last longer. Some little experimental work was also required to determine the length of time which the cutter should be run before regrinding. A cutter of this kind can satisfactorily mill 42 cast steel boxes (84 sides) before regrinding, although these boxes are rough, sandy and uneven.

It has been found that in milling cast steel it is very important that a good stream of soda or compound be forced onto the cutter, and the suggestion is made that milling machines to handle this class of work should be provided with a large capacity pump and have a comparatively large reservoir on top of the housing. Two pipes could run down from the reservoir to the cutter and each one end in a T with a large number of small holes in it, so that a good stream of lubricant could be forced onto the cutter over its entire length.

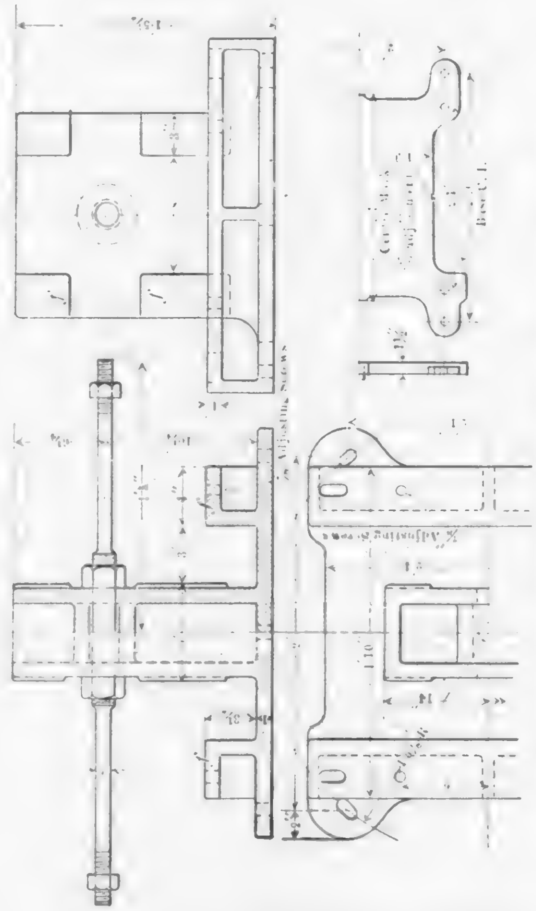


FIG. 3—JIG FOR HOLDING DRIVING BOXES WHILE MILLING THE SHOE AND WEDGE FITS.

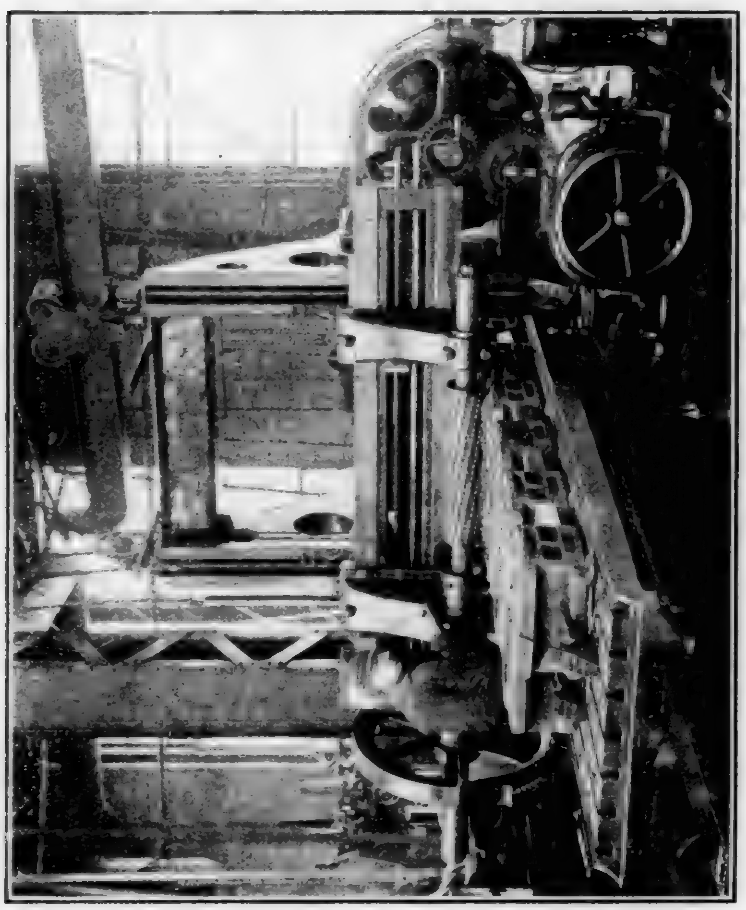


FIG. 1—MILLING THE SIDES OF THE DRIVING BOXES.

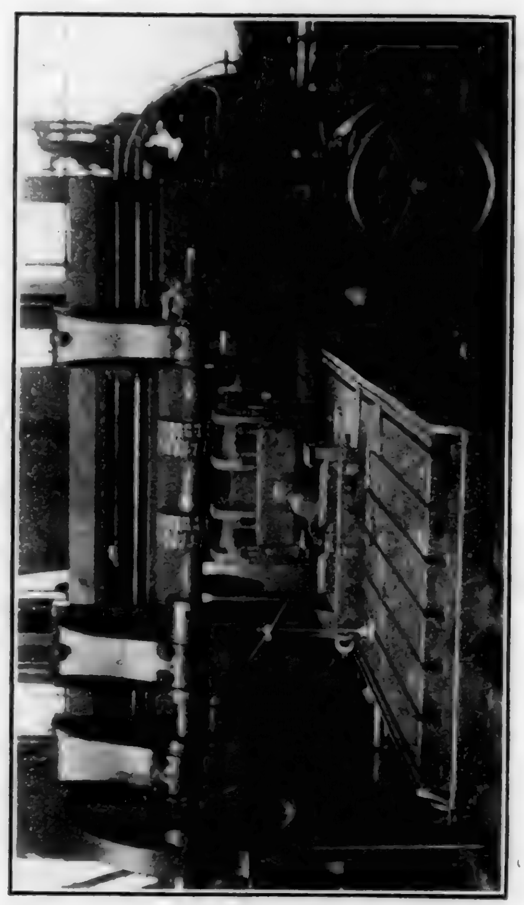


FIG. 2—MILLING THE SHOE AND WEDGE FITS.

Fig. 2 shows the method of milling these boxes for the shoe and wedge fits. The cutters are 12 in. in diameter of the high-speed steel inserted plate type. It will be seen that each tool is made in two pieces, and that the cutters overlap each other. It is thus possible to vary the width of the cutters and thus keep them up to standard size. These cutters will mill about 30 boxes without regrinding. In cutting cast iron they run at 12 r.p.m. and feed at the rate of 1⅝ ins. per min., while in cutting cast steel they may be run at 15 r.p.m. with a ⅝-in. feed per min. Fig. 3 shows in detail the jig for holding these boxes. The base plate of the jig is bolted to the table of the miller, and the jig is pivoted on this plate and may be set at any desired angle. The jig holds two boxes, which are clamped to its side by means of a long stud, and the box is adjusted for height by means of the two adjusting screws, and is clamped at both the front and back. One man will mill the shoe and wedge fit for at least 12 cast iron boxes (8½ to 9½-in. journals) in a day of 10 hours or 8 cast steel boxes of the same size. We are indebted for this information to Mr. H. H. Vaughan, superintendent of motive power; Mr. H. Osborne, superintendent of shops, and Mr. Gustave Giroux, piece work inspector.

10-WHEEL PASSENGER LOCOMOTIVE.

DELAWARE, LACKAWANNA & WESTERN RAILROAD.

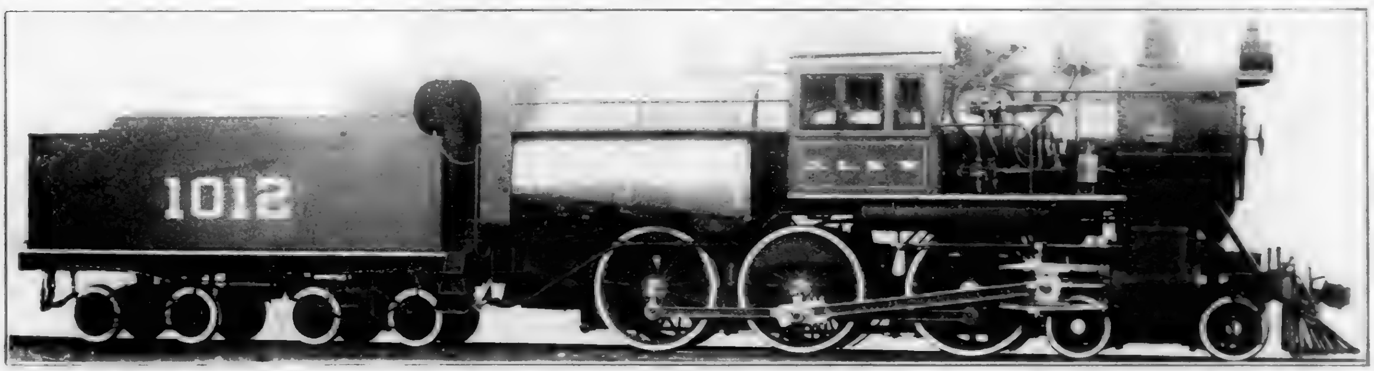
The Delaware, Lackawanna & Western Railroad has just received from the Schenectady works of the American Locomotive Company five 10-wheel passenger locomotives, which are the most powerful locomotives of this type ever built for passenger service. They have a tractive power of 35,100 lbs., 22½ by 26-in. cylinders, a total weight of 201,000 lbs., and carry a boiler pressure of 215 lbs. The driving wheels are 69 ins. in diameter, and, although rather small for a 10-wheel passenger engine, are large for a locomotive of this type with a broad firebox. The driving wheels are the same size as those used on the 4—4—0 type engines on this road. This is the heaviest passenger engine of this type, being 2,000 lbs. heavier than similar engines built for the Lehigh Valley Railroad, which have a tractive power of 31,380 lbs., 21 x 28-in. cylinders, 68½-in. driving wheels, a total weight of 199,200 lbs., weight on drivers 150,200 lbs., and carry 205 lbs. steam pressure.

The only passenger engines more powerful than these, of which we have a record, are the 22 x 28-in. Pacific type locomotives built for the Southern Railway, which have a tractive power of 35,194 lbs., a total weight of 218,950 lbs., weight on drivers 141,650 lbs., 72-in. drivers, and carry 220 lbs. of steam.

The Prairie type locomotives used for freight and passenger service on the Chicago, Burlington & Quincy Railroad, described on page 78 of our March, 1905, issue, have a tractive power of 35,050 lbs., or a little less than that of the Lackawanna engines. Considering the tractive power, the total weight of the Lackawanna engine is remarkable low. The leading dimensions are as follows:

4—6—0 TYPE PASSENGER LOCOMOTIVE, DELAWARE, LACKAWANA & WESTERN RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Fine Anthracite
Tractive Power	35,100 lbs.
Weight in working order	201,000 lbs.
Weight on drivers	154,000 lbs.
Weight on leading truck	47,000 lbs.
Weight of engine and tender in working order	321,000 lbs.
Wheel base, driving	14 ft., 4 in.
Wheel base, total	25 ft. 6 ins.
Wheel base, engine and tender	54 ft. ¼ in.
RATIOS.	
Tractive weight ÷ tractive effort	4.38
Tractive effort x diam. drivers ÷ heating surface	717.
Heating surface ÷ grate area	[illegible]
Total weight ÷ tractive effort	5.72
[illegible]	
Kind	Simple
Diameter and stroke	[illegible]½ ins. x 26 ins.
Piston rod, diameter	[illegible]
[illegible]	
Kind	[illegible]
Greatest travel	[illegible] ins.
Steam lap	[illegible]
Setting 1-16 in. lead in full gear forward [illegible] in. lead at 6 ins. cut-[illegible]	
WHEELS.	
Driving, diameter over tires	[illegible]
Driving, thickness of tires	[illegible]
Driving journals, main, diameter and length	[illegible]
Driving journals, others, diameter and length	[illegible]
Engine truck wheels, diameter	[illegible] ins.
Engine truck, journals	[illegible]
[illegible]	
Style	[illegible]
Working pressure	[illegible]
Outside diameter of first ring	[illegible]
Firebox, length and width	[illegible]
Firebox plates, thickness	[illegible]
Firebox, water space	4 ins.
Tubes, number and outside diameter	398 2-in.
Tubes, gauge and length	12, 15 ft. 3 ins.
Heating surface, tubes	3,156.3 sq. ft.
Heating surface, firebox	[illegible]
Heating surface, total	3,378.0 sq. ft.
Grate area	94.8 sq. ft.
Exhaust pipe—Double nozzles	[illegible] and 3⅝ ins.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 9-16 in.
Centre of boiler above rail	116½ ins.
[illegible]	
Tank	U shaped with hood at front, D., L. & W. std.
Frame	10-in. channels and plates
Weight, loaded	120,000 lbs.
Wheels, diameter	33 ins.
Journals, diameter and length	5 x 9 ins.
Water capacity	6,000 gals.
Coal capacity	[illegible]



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(Established 1832).

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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If a man has become a machine because of the constant repetition of the same work over and over again, it is because his treatment has been mechanical and he has been brought up by machine methods. It is possible to surround labor involving the greatest drudgery with conditions which make life worth living, and if a man becomes mentally and physically a machine it is some one's fault. If your men are mere machines, there is something wrong with the method, and the men themselves are not to blame. Perhaps the trouble is "higher up."

A motive power officer was recently criticized because of the character of a great increase in the number of train delays. The matter became serious and in self-defense he sent several young men to keep tab on the trains leading to the most serious complaints. After satisfying himself the superintendent of motive power requested the transportation department to furnish representatives to act with the motive power representatives and jointly take a record of the trains. This revealed the fact that 17 per cent. of the delayed time was agreed upon as being due to the motive power department and 83 per cent. to others. By looking after such matters as the station stops, this trouble was straightened out. It seems strange that such criticism can arise. It could not if the departments really endeavor to help each other.

In connection with the introduction of a device for aiding locomotive firemen, a study of the work of these men shows that for each ton of coal fired approximately 600 distinct movements are required of the firemen, divided as follows: 1. Filling the shovel with coal. 2. Opening the door. 3. Picking up the shovel. 4. Throwing the coal into the firebox, and 5th, Closing the door. These movements are represented for every shovel full of coal, and the analysis throws a strong light upon the work of the firemen, indicating the reason why brute strength is a necessity to these men. With a device which opens the fire door automatically, due to the operation of a valve by the firemen's foot, the number of movements for a ton of coal are reduced to 234. Assuming that ten tons of coal are fired upon the trip, with a No. 4 scoop, holding on an average 17 lbs. of coal, a fireman ordinarily makes 6,020 movements. With a device which opens the door 2,340 movements are required, which is a reduction of 3,680 in the handling of ten tons. In a long freight run, requiring the consumption of 20 tons of coal, the fireman's movements ordinarily aggregate 11,700, of which 7,020 may be eliminated by the employment of the device.

MALLET COMPOUNDS FOR ROAD SERVICE.

Thus far the Mallet type does not seem to have been seriously considered in this country, except for helper service on very heavy grades. It is certainly worth while to consider the possibilities of this type for heavy main-line freight service. Some of the advantages offered may be enumerated as follows:

(1) Economy in fuel; (2) all weight available for traction; (3) large tractive power; (4) superior ability in starting heavy trains; (5) even pull on draft gear; (6) avoidance of severe jerks in starting in case of slipping; (7) division of work among an increased number of parts.

These classifications, as shown in experience with the large Baltimore & Ohio Mallet compound, seem to justify high expectations from this type in heavy road service.

LOCOMOTIVE EQUIPMENTS.

The importance of systematically looking after tools and equipment on locomotives may be judged by a statement made in an article on this subject on another page of this journal. A road with something over a thousand locomotives spent $70,000 per year to maintain this equipment. Each engine was supposed to carry an equipment valued at $65, but in spite of this large expenditure, on an average only $20 worth of equipment could be found on any one engine, because of the lack of system and proper care. Such a condition must necessarily be responsible for many delays and inconveniences to traffic because of the proper tool being absent when most needed. The article in question should be studied carefully, and it is valuable because it not only considers the tool equipment on an engine, but tells exactly how to look after it systematically in order to obtain the best results. It is the more valuable because it comes from one who has had considerable experience in this work and is in a position to speak authoritatively.

THE VALUE OF A SMILE.

A certain man who is very successful as a manager of men and one who has brought order out of chaos in a relatively short time is one who while seriously minded wears a pleasant expression and is always ready to smile. He is working under extraordinary difficulties, and whatever expression his face may wear when the day is over and he is out of sight of the shop and of the men he never allows the men to be discouraged while he is about the work, but supports and enthuses them by his confident appearance. This officer says to his foreman "You must look cheerful no matter what you may be up against."

What would become of an army undertaking a difficult manœuvre in the face of the enemy if the superior officers were glum and discouraged? How will the privates in the ranks feel if they see that their officers are doubtful and afraid? Look pleasant, it will give your men confidence and they will help you because of your own confidence and their confidence in you. The gentleman referred to has on his desk the rather common reminder: "Do It Now," but has added to

it the words, "And Smile." If the readers know who is referred to let them watch the result in his progress.

MILLING CAST IRON AND CAST STEEL.

For a considerable time we have advocated a more extensive use of milling machines in railroad shops. In one shop, recently visited, the shop superintendent strongly scored the slab miller, but investigation showed that he had a machine which was over twenty years old and not at all adapted to modern machine shop practice, and it was no wonder he was disgusted with it. Other shop superintendents are enthusiastic concerning the milling of mild steel, wrought iron or bronze parts, but are skeptical as to the advisability of milling castings, because of the effect on an expensive milling cutter of the hard scale and sand. A visit to the shops of the machine tool builders reveals the fact that they are using these machines to considerable advantage in milling castings; it has been suggested, however, that possibly these castings are of a better grade of cast iron than ordinarily furnished the railroad companies, and possibly there is some truth in this. It is interesting to note that several railroad shops are milling certain of their castings, or are experimenting along this line. On another page of this journal is an interesting article on the milling of cast iron and cast steel driving boxes at the Angus shops, and it would appear that such work can be handled very successfully if the cutters are properly designed and taken care of. It is, of course, necessary to determine the speeds and feeds at which the cutters can be operated to get the best results, and with cast steel it is important to furnish a plentiful supply of lubricant to the cutter. In order to gain successful results it is also necessary that the machines be of heavy and rigid construction, so that there will be practically no vibration. The milling cutters should be of high-speed steel of the inserted type. It is surprising how easy it is to keep these sharp and in good condition if the proper facilities are provided for grinding.

ROCK ISLAND LOCOMOTIVE REPAIR SHOPS.

The building of these shops is a good illustration of "Western push." Judging from the remarkably short time in which they were planned and the buildings erected, we might expect to find that they were incomplete or else closely modeled after some existing plant. It is rather surprising to find, on the contrary, that they are strictly up-to-date in all respects and that many new and radical features have been added, which makes it possible to handle the work quickly and economically. In the article which appears on these shops in this issue, which is the first of a series, the arrangement and construction of the buildings is described. The most noticeable features about the buildings are the splendid daylighting, simple construction and the duplication of detail design, thus reducing not only the first cost of the buildings, but also the cost of maintenance.

Another feature, which is to be commended, is the arrangement of the large locomotive shop with the erecting department in the middle and the machine and boiler departments on either side with no walls between them. In case one department becomes crowded, it is very easy to extend it over into one of the other departments. In designing a large shop of this kind, it is difficult to determine how much space should be devoted to each department, and, as the locomotive designs change, or as the motive power becomes older, or as the amount of manufacturing for other points on the road increases, one department is quite liable to become overcrowded, and it is therefore wise to arrange these three departments so that their limits may readily be changed to suit new conditions. As practically no restrictions were placed on the arrangement of the buildings, the layout plan may be considered as an ideal one for the conditions for which it was intended and is worthy of careful study. It will be noted that generous allowances have been made for future extensions to all of the shops.

THE COST OF LOCOMOTIVE REPAIRS PER 1000-TON MILES.

BY HARRINGTON EMERSON.

There ought to be a normal relation between 1,000-ton miles and locomotive repairs, or between miles run and repairs. There is not. Each railroad makes up averages, but what is the value of averages except for life insurance? What is the normal cost of repairs per miles run when in a given case out of 144 shopped engines, none wrecked, 36 averaged $0.17 per mile between shoppings and other 36 averaged $0.0287 per mile? Of the first 36, 6 averaged per mile $0.53 and of the second 36, 6 averaged $0.0128 per mile.

Here again we have averages, but there is no average in the fact that a certain engine cost per mile $0.0073, and another engine $0.50 or 70 times as much. What deduction is to be drawn when the engine costing per mile $0.0073 weighed 210,000 lbs. exclusive of tender and the engine costing $0.50 per mile weighed 99,500 lbs. exclusive of tender? Evidently none of any value. It is much more important to find out why the repairs on one engine cost 70 times as much as the repairs on another engine per mile than it is to speculate as to whether the repairs on light engines cost more per 1,000-ton miles than the repairs on heavy engines. An opinion may be ventured, even an assertion made, that in a shop employing best modern methods the repairs per 1,000-ton miles on a modern monster will cost less than the repairs formerly cost per 1,000-ton miles on the old style small engines of fifteen years ago. For this assertion, convincing proof is lacking chiefly because there are few railroad shops, one might say none, in which the best modern methods are employed. A modern shop is one which knows what it is about unto minutest details both as to why and how, and acts accordingly; not a shop with a large array of expensive modern tools and Egyptian darkness as to causes and results.

Even if the assertion were proved, even if big engines could be maintained more cheaply per 1,000-ton miles than small engines formerly were, the battle as to shop costs between big engines and small engines is not solved, since perhaps the old engine in the shop with modern methods might far surpass in lessened cost of maintenance not only its own type in the long ago shop but its big rival in the same shop. The fact remains that as yet locomotive repair costs cannot be wholesaled by weight alone. There are identical big locomotives that are very, very cheap to maintain and there are others that are very costly and the same variation occurs among the smaller locomotives.

To date we cannot safely generalize. Railroads are peculiar not to say funny. If they were elevated or surface lines levying a flat rate of fare, one could understand their flat methods of running their shops and averaging engine repairs. But in their revenue they are most particular to go into details. No zone system for them with unit rates, good between any two stations. Each passenger has to buy a ticket for just the distance he intends to travel, no more or no less, he must use it on the day purchased and be checked up when he enters the train, when he leaves it and several times between, so fastidiously careful are the railroads to be certain that they obtain all that is coming to them. When it comes, however, to spending the money laboriously collected from the grumbling public all methods of precaution are overlooked. Engines are butchered out on the road and are cobbled in the shops and both the butchering and the cobbling are averaged.

The speed of trains and the speed of individual engines has been tested close up to the limit, but is there a single engine in America of which we can definitely say that its repairs have cost a minimum even for that engine, much less the minimum per 1,000-ton miles of all engines. Until facts are available to give this information not only about one engine but about all engines, we are a long way from being able to pro-

nounce as to the relative value of engine types and performances. Such facts are theoretically easy and practically hard to obtain and yet if followed up they are more profitable than any Yukon gold mine. They are theoretically easy because they require neither expensive accounting nor exasperating detail tabulations. They are practically hard because very few have faith in their value and they are not available from the way railroad accounts have been hitherto kept. On the same railroad in neighboring shops I have found such a standard operation as flue welding and tipping to be done at the rate of 12 an hour, 25 an hour, 40 an hour and 100 an hour. The same disparity exists in other normal operations. The way to cheapen engine repairs is not to build new shops and equip them with heavy modern machinery, but to keep detail account with every single engine and tabulate not only every deficiency that develops in service, but also standardize every shop operation and practice and establish its normal cost.

The first road that systematically and intelligently follows this course will take a long step towards bringing down all its engine repairs to a phenomenally low normal, and in its accounts we shall no longer find variations of 70-fold in repair cost per mile run.

COMMUNICATIONS.

A GOOD SUGGESTION CONCERNING COMPOUND LOCOMOTIVES.

To the Editor:

The brief editorial on the failure of the compound locomotive, which appeared in the September issue, calls to mind a conversation which I had—more than two years ago—with an engineman on a road where the compound was, at that time, extensively used in freight service. I was riding in the cab, and noticed, after we were well started, that he continued working the engine single expansion. On asking him about it he informed me that the starting valve was usually left open. I endeavored to explain the advantages of compound working and the use of the valve; he appeared interested, and finally said: "All right, you can close it," and during the remainder of the run, the valve was always closed after the train was started.

It seems to me it is a mistake to tell a man to do a certain thing without telling him *why* he is to do it. He may be informed that the starting valve is to be closed after a certain rate of speed has been attained, but unless he understands why that is desirable he is liable to lose interest and forget all about the matter. It may require time and trouble to give such an explanation, but without doubt it would, in many cases, prove a paying investment in the end.

COMPOUND.

WALSCHAERT VALVE GEAR.

To the Editor:

Having read the numerous articles which have appeared in the AMERICAN ENGINEER AND RAILROAD JOURNAL, relative to the advantages and disadvantages of the Walschaert valve gear as applied to locomotives, I notice that there is a great deal of discussion on the distribution of steam obtained from it, due to constant lead at all points of cut-off. One of the points being discussed very much is that on account of the amount of lead used with the Walschaert gear, when the engine is working at full stroke the pre-admission will have a bad effect when trying to start a heavy train, and for that reason it is considered a very strong argument against the Walschaert valve gear. I am of the opinion that this is of very little detriment to a locomotive; for instance, take a locomotive with the Walschaert valve gear having a 3-16 in. lead and cutting off at full stroke the pre-admission is about 3-32 of an inch. If you stop to think of the position of the crank pin at this time, it will be seen that there will be very little retarding effect upon the engine from this source, and as an engine is working at full stroke, or nearly so, at a very small percentage of the time, I cannot but see that the advantage is with the Walshaert gear in this respect, on account of decreasing the pre-admission when the engine is working at short cut-off; for instance, an engine with 3-16 in. lead working at 6-in. cut-off the pre-admission is about ½ in., whereas with the same engine equipped with the Stevenson link motion, the engine would in all probabilities be set ¼ in. to 9-32 in. lead at 6-in. cut-off. With this lead the pre admission would be about ⅞ of an inch, and it is when the preadmission is as great as this that the retarding effect upon a locomotive is considerable when being crowded to a high rate of speed.

A great many try to cut down the compression in the cylinders by giving the valve more exhaust clearance. My belief is that very little, if any, lead is required on a locomotive either at short or long cut-off, and would recommend decreasing the retarding effect due to compression and pre-admission by cutting down the lead at short cut-offs. The Walschaert valve gear offers a splendid opportunity for this because you can set the Walschaert gear engines line and line or 1-16 in. lead at all cut-offs, and an engine with this amount of lead both at full stroke and at short cut-offs will start a train just as quickly and run faster than an engine which is set line and line or 1-16 in. lead full cut-off, but when hooked up to short cut-off the lead is increased to ¼ or 5-16 in. The Walschaert valve gear on locomotives is the coming gear. Its advantages over the Stevenson link are many, and its disadvantages very few and of very small value.

Cleveland, Ohio. J. T. CARROLL.

WALSCHAERT VALVE GEAR.

To the Editor:

In the communication from Mr. C. H. Quereau on Walschaert valve gear, published in your September journal he infers a condition which the writer has found does not exist, at least on an engine recently fitted with this valve gear on the Lake Shore and Michigan Southern at Elkhart, Ind. On page 317, Mr. Quereau states that when working in full gear, steam will be admitted to the cylinder when the piston is about 2 ins. from the end of the stroke.

We find that on the engine referred to, this pre-admission is practically nothing at full stroke, the valve beginning to open when the piston is 3-32 of an inch from the end of its stroke. Practically this same condition exists on the New York Central engine equipped with this valve gear, of which valve motion cards are given on page 214 in the June number of the AMERICAN ENGINEER, in which the pre-admission is shown as being zero, although it is hardly possible that the valve should move to the amount of the lead at the beginning of the stroke without the piston moving, at least, a measurable amount at the same time. With this slight amount of pre-admission it seems to the writer that Mr. Quereau's claim of excessive strains due to it, is hardly justifiable. The pre-admission increases as the cut-off becomes shorter, although the lead remains constant, and thus just those conditions prevail which Mr. Quereau (and the writer) seems to think desirable, namely a longer time for the steam to enter the cylinder at the higher speeds.

OSCAR ANTZ.

THE RAILROADS AND LOCOMOTIVE DESIGN.

To the Editor:

Your recent article on broken frames leads to the question, "Are the designs and types of locomotives which the builders bring out with such commendable enterprise sufficiently studied by those having charge of the operation and repairs of the machines?" Written reports of breakages, cracks, or excessive wear discovered in any part of the locomotive or tender on the road, in the engine-house, or in the shop, also of poor steam performance, would, if thoroughly studied and investigated, result in an improvement in American motive power, the faulty condition of which is forcing itself upon the attention of the travelling and investing public. The mere addition of metal to a fractured section may usually be construed as a failure to comprehend the real cause of the trouble, for a change in the location of a bolt or a rib, the obviation of eccentric loads and bending, an increased rigidity or flexibility, near, or at a distance from, the break, will often accomplish what no mere amount of metal can. A common mistake consists in placing a plain rib on the tension side of an iron casting. Such a rib is often a source of weakness rather than strength.

Besides lateral vibration and slack in driving-boxes, connecting rods, and tender buffers, unnecessary bending moments will be found to be frequent causes of frame breakages. For example, many 4-6-0 engines have the forward equalizer fulcrums bolted to slender, lower frame rails, with the only struts between the upper and lower rails located at some distance ahead. The rails usually break at their back ends. Another example is furnished by

many recent 4-4-0 engines having no strut from the frame to the boiler between the guide yoke plate and the firebox. The supporting force from the front hanger of the forward driving spring produces a beam action in the frame, and breakages are frequent, especially if a poor type of pedestal binder is used. A strut plate from the frame to the boiler over this pair of spring hangers will do away with the bending and will also prevent lateral vibration. The high, flexible guide-yoke plates now in use might safely be bolted to the boiler, relieving the frame of part of the crosshead load applied at every stroke while the engine is backing. In the older designs the vertical forces were more effectually arranged for the balancing of each by one in line with it.

It is but a simple algebraic operation to determine the correct lengths of spring hangers and proportions of springs; and there is no necessity for equalizers to stand at angles of five to ten degrees or for engine and tender chafing irons to be five or six inches out of line.

Some improvement might be effected in boilers by the erection of simple apparatus for measuring the distortion when test pressures are applied, and comparing it with the form of staying and the records of repairs. A boiler with radial stays arranged approximately as described in your correspondence columns of February, 1901, has now been in service aboout two years, and in that time has but once required to have its fire drawn on account of a firebox defect, and that was for a slight leak in one tube.

G. E.

FLEXIBLE STAYBOLTS.

To the Editor:

I have read with much interest the article in your September paper, entitled "Methods of Installing Flexible Staybolts," which leads me to bring up several points stated therein for discussion. Yes, I agree with the author: it is vitally important to the success of the flexible stay that good work always be done in the installation of the complete bolt. And yet, how can we reconcile this statement with the one made further on in the article, viz.: that the cost of installation should not exceed 25 cents per bolt and, when installed in large quantities, should be as low as 15 cents per bolt? All of us who have worked or closely observed conditions in modern locomotive repair shops know that good work cannot be obtained at the figures named by Mr. Stafford. I would be much more inclined to put the installation cost at from 30 cents to 40 cents per bolt, or, in large quantities, at 25 cents per bolt. I suppose the author, when he gives such low figures for large quantities, takes it for granted that a large installation would only be made when a locomotive came in for general repairs, in which case special care could be taken to charge a large percentage of this cost to one or more of the many other items of expense. This is all right for the staybolt's reputation as a money saver, but does it represent the true facts of the case?

The first essential demand of any appliance, where possible, both from a mechanical and a financial standpoint, is simplicity in design and construction; mechanical to eliminate blunders and poor installation by careless workmen, and financial to save on the expense of first cost of installation and maintenance. Now, it seems to me, after a careful perusal of Mr. Stafford's article, that a staybolt, the life of which depends to a great measure upon the many and costly operations as laid down by him, should be entirely eliminated from boiler practice as wholly uneconomical from every point of view. Uneconomical, because we get no visible return on our high first cost in the longer life of the so-called "flexible" over the ordinary "rigid" stay.

I would also like to differ with Mr. Stafford that staybolt breakages have in no sense diminished, regardless of the quality of iron used. Would say, in reply to this, that the highest grade of piled iron, such as is used altogether by the Falls Hollow Staybolt Company, makes a truly flexible bolt. Their claim to flexibility in its truest sense is backed up by all motive power officials who have any knowledge of mechanics or metallurgy and by those who have not this knowledge from the practical results that they have obtained in its use. Whatever claim the so-called flexible stay has to flexibility, it must relinquish when it comes in contact with hard water, for it has been found, from general practice, that the sediment and incrustation thrown down by hard waters does not spare the aperture surrounding the outside head of the bolt any more than it does the flues or any other part of the heating surface, and, as soon as this aperture gets filled with a deposit or incrustation of sediment, we have the simplest kind of a rigid bolt. But what a price to pay for an ordinary rigid stay!!

In summing up, we can best describe this so-called "flexible" stay by quoting from a paper read before the New York Railroad Club by Mr. Livingstone, the best expert on staybolt material and practice in this and any other country, when he says that the kindest thing that can be said of the "flexible" stay is that they sometimes use the best quality of piled staybolt iron in their manufacture. There are many other points open to discussion in this article, and I would greatly enjoy seeing them threshed out in the columns of your paper.

Very truly yours,

F. C. LIPPERT, M.E.

THE DESIGN OF BRAKES.

To the Editor:

Will you kindly allow me to submit the following method of designing brake heads and hangers? While the example selected is for inside-hung brakes on eight-wheel cars, the modifications necessary to apply the principles to other cases are obvious.

Let A = weight on each wheel.
B = percentage braking "power."
C = coefficient of friction.
D = height of center plate bearing above rail.
E = wheel base of truck.
F = factor explained below.
G = angle whose tangent is C.

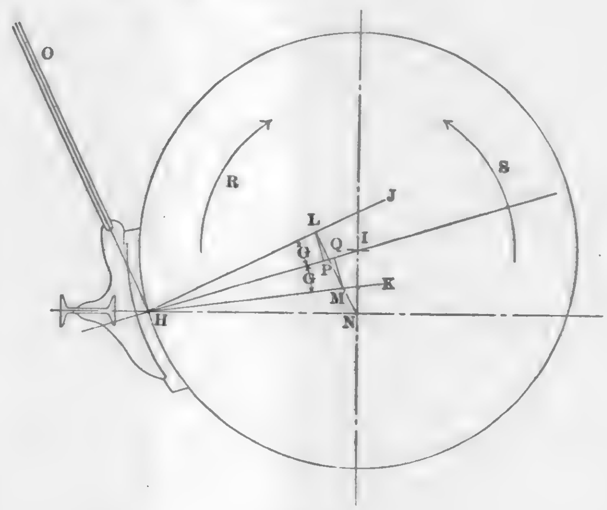


FIG. 1.

Draw HI (Fig. 1) from the center of the brake shoe through the center of the wheel, and draw HJ and HK, making angles IHJ and IHK equal to G. Lay off HL to some scale to represent $AB\left(1 - \frac{2\ BCDF}{E}\right)$ and HM to represent $AB\left(1 + \frac{2\ BCDF}{E}\right)$. Draw a horizontal line through H, and draw LM, extending it to intersect the horizontal line at N. Through H draw HO parallel to LN. Now HO will be the center line of the hanger and HN the center line of the brake beam. The hanger may be attached to the head anywhere in the line HO and the lever may be attached to the beam anywhere in the line HN. Draw LP and MQ perpendicular to HI. When the wheel is going in the direction R, HN is half the pull to be exerted by the lever on the beam, MN will be the stress in the hanger, HQ will be the resultant normal pressure of the shoe against the wheel (it should be noticed that it is applied at the center of the shoe), and QM is the retarding force due to the friction of the shoe on the wheel. The stress in the hanger and the pull of the lever, combine to give a resultant HM, which is decomposed into a normal pressure HQ and a tangential resistance QM. Similarly, when the wheel is turning in the direction S, HN is half the pull of the lever, LN is the tension in the hanger, HP is the resultant normal pressure of the shoe, and LP is the retarding force. The brake head may now be laid out, making thickness of shoe equal to that when the shoe is a little less than half-worn out. The diameter of the wheel should be the average to be expected during the life of the wheel, and the hanger should be as long as convenient.

It will be found that wide variations in the coefficient of fric-

tion will make but a slight difference in the direction of the hanger. The factor F, however, will make considerable difference. It can vary between 0 and 0.85 or 0.90. If the truck is light compared with the weight of the car body, if the brake gear is to be kept in first-class repair so that there will be no danger of cramping the hanger, if the variations in diameter of wheel and thickness of shoes are small, and if it is desired to obtain the highest possible braking force without danger of sliding the wheel, a high value of F should be selected. Otherwise F may be reduced according to judgment. When F is 0, the hanger is perpendicular to HI, and the braking forces on the forward and back wheels are equal, the greatest possible advantage of inside-hung brakes being thereby destroyed.

The above rule, gives, to the greatest possible extent, an arrangement which insures even wear of the shoes and a maximum possible braking "power" without sliding the wheels. The head may be rigidly fixed on the beam, with no detriment to its action. A third hanger at the end of the brake beam fork is advisable to steady the beam and to be sure that the shoes do not drag when released. It should be of the same length as the brake-head hangers, and should be parallel with them, but it need not be at the same height. Such hangers can, to a limited extent, overcome defects in the design, but it is not wise to impose more upon them than is necessary.

Since the forces exerted by the rods upon the levers are horizontal, it follows that the levers must exert horizontal forces on the beams. The beam should, then, be horizontal. Inclining it merely changes the height of the lever, as far as the action of the shoe on the wheel is concerned. It places the lever in an awkward position for connecting it to the rods, sets up stresses in the third hanger, and produces the torsion in the beam which has been so prolific a source of failures of beams by starting the buckling.

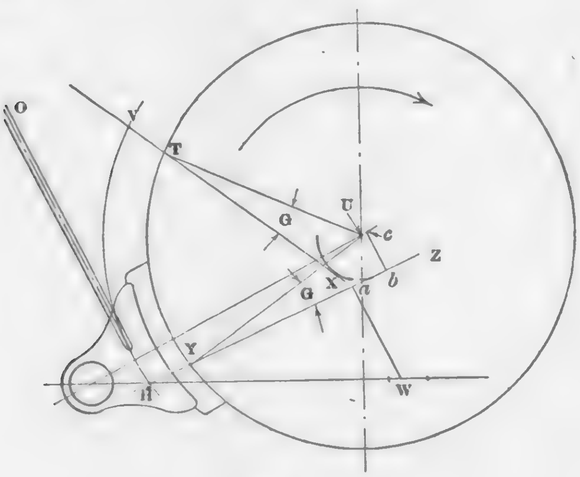


FIG. 2.

The action of an existing arrangement can be studied as shown in Fig. 2. The center line of the hanger and the horizontal line through the beam, intersect at H. Lay off WH to represent half the pull of the lever. Draw any radius TU, and draw TX, making angle G with it. Extend TX to meet, at V, an arc drawn through H with U as a center. Transfer lines TU and VX to YU and HZ. Draw Wa parallel to HO. Wa is then the tension in the hanger, and Ha is the force exerted by the shoe on the wheel. This is transferred to Yb and decomposed into Yc and bc, Yc is the resultant normal pressure when the wheel is turning in the direction of the arrow. It is applied far from the center of the shoe. The pressure at any part of the shoe can be determined by the well-known method of eccentric loads. In this case the intensity of pressure after the shoe has become well fitted to the wheel, will be about 0 at the top, and at the bottom it will be about twice as much as it would be if evenly distributed. The procedure for a rotation of the wheel in the opposite direction will be the same except that angle G is laid off on the other side of line TU. In this example, the action would be slightly better, but the pressure would still be greatest at the bottom. Unless, then, the third hanger exerts great force to hold the brake beam fork down, the shoe will wear almost entirely at the bottom.

The correctness and convenience of the above theory are evident. As is to be expected, practical experience checks the results.

G. E.

ENGINE EQUIPMENTS.

BY H. EMERSON.

The railroad is the skeleton of our civilization; locomotives are the muscles; whatever pertains to the operative efficiency and economy of the locomotive is of interest. This subject of engine equipments is of much interest, for upon the equipment, and its care and use, depends largely the efficiency of locomotive service and often the economy of time and property.

Engine equipments are made up of such items as are included in the following list:

APPURTENANCES.

Grease cups: rods, guides.
Flags: red, white, green, blue, yellow.
 Flag holders or brackets.
 Flag boxes.
Headlight: front, rear.
Lanterns: red, white, green, blue globes.
Lamps: blizzard or classification marker.
 Slides: red, white, green, blue.
 Lamp brackets: front end, pilot, rear tender sides, rear tender center.
Cab lamps: steam gauge, water glass, air gauge, steam heat gauge.
 Brackets for same.
 Guard for water gauge glass.
Boxes: seat, tender.
Fire door chains.
Coal boards: front, side, back.
Push poles or stakes.
Torches.
Cab curtains: back, sides.
Seat box cushions.
Hooks: for clothes, for keys.
Arm rests.
Gauge cock drip trough.
Tank ropes.
Electric cab block signals.

APPLIANCES.

Coal scoops.
Oil cans: engine, valve, headlight and signal. Oil supply cans.
 Engine and valve oil oilers, long spout, short spout, squirt can.
 Dope pails, tallow pots and covers, grease cup charges.
Fire tools: single or double hook, slice or slash bar, shaker bar, coal pick, hoes long and short, pokers for firebox and for front end.

TOOLS.

Hammers: hard hand, sledge, combination, soft.
Wrenches: Monkey or screw, Stillson or pipe, alligator, double-end set-screw, double-end eccentric set screw, double-end wedge bolt, double-end oil cup, double-end rod, air pump spanner, lubricator spanner, injector spanner, injector knuckle, main rod wrench, crank-pin nut wrench.
Chisels: flat, long cold, cape, round nose, bars.
Sets, punches, files, drifts, scrapers.

SUPPLIES.

Headlight chimneys: glass, mica.
Water glasses, gaskets.
Lubricator glasses, gaskets.
Hose: airbrake, dummy brake, air signal, dummy signal, steam, all couplings (including heater to water scoop), gaskets.
Lamp wicks, wicking.
Waste.
Bell cord.
Brasses, engine truck, tender truck.
Bolts and nuts.
Rod keys.

EMERGENCY.

Replacers or wrecking frogs.
Chain and hook, wrecking or switch.
Jacks: large and journal box, jack levers.
Pinch bars.
Fusees and torpedoes.
Guide blocks.
Main crank pin blocks.
Valve stem clamps.
Medical boxes.
Plugs for cylinder release valve.
Emergency knuckle.
Ax and saw.

MISCELLANEOUS.

Water buckets, brooms, brushes, sponges, sponging irons, water coolers or kegs, drinking cups, tripoli can, time card holder, fuel books, stores books, time slips, framed instructions, lubricator, electric headlight, tool list, seal for tool box, lock for same, portable tool boxes.

This list is not comprehensive; it is only representative, of actual practice here and there.

How should the engine equipment, made up of such items, be handled? Shall we deal with engines as individuals, or with engine crews? Shall we "standardize" equipment, making it of general uniformity for all engines, all enginemen, all conditions, or shall we vary the equipment to suit each case? Shall our aim be to have the smallest practicable equipment, or shall we make traveling store-houses of our engines in the endeavor to provide for every chance? And, in the end, shall or shall not economy of supplies and supervision be the determining watchword?

Of course, every operating locomotive in the land carries some equipment—else it could not run. Also, most of our larger roads have made some endeavor to systematize this

problem—as is evidenced by printed tool checking lists, and occasional roundhouse tool inspectors: and in one way or another the crews get supplied. But, generally, this detail of railroad operation is overlooked or neglected by the higher officials (general manager and superintendent of motive power), who alone can bring about any lasting good in the matter. At the outset, therefore, if anything is to be accomplished along this line, it must be done on a large scale, on a thorough scale; and in the doing, money (tens of thousands), time (months—a year), must be spent. This once done, actual annual savings in stores and in expense should surely result, with also much greater satisfaction and efficiency of the service.

HOW TO IMPROVE CONDITIONS.

To be most completely worked out, the matter should be in the hands of the superintendent of motive power, who might, however, call in to advantage an advisory committee of, say: mechanical engineer; a master mechanic or roundhouse foreman (usually too busy!); a superintendent; a storekeeper (preferably a man intimately conversant with the conditions of issuing stores to engine crews, who should also in the present case familiarize himself with the annual accounts for the road respecting engine equipment supplies); an engineman (member of engineers' committee?) This committee could not meet as a whole very well oftener than once in a month, and each member could hardly do more than give some attention to the matters affecting his particular interests; its province would be advisory and debative—possibly in most cases decisive; the co-ordinating executive work should be wholly in the charge of someone specially delegated to the task, he to be responsible to the superintendent of motive power, and to consult fully with members of the committee individually, as well as in session. Representing the superintendent of motive power, this man's rank, while carrying out the organization and in respect to it, should be above that of the master mechanics; that is, he should have ample authority to put the work into effect; he might conveniently do this by using the superintendent of motive power's name rather than his own.

What state of affairs will this man (whom we may call equipment inspector), and this committee find? Locomotives running into the dozens of classes, each class having slightly different requirements in equipment (i.e. rod wrench sizes, water-glass lengths), even locomotives of a class often differing; requirements varying also with different kinds of service (freight, passenger, switch), on main line and on branches, on different divisions; pooled engines will be devoid of almost all equipment—what remains being left only because unfit to take away!—assigned engines, on the other hand, having tool-boxes fairly bursting with the greatest assortment of miscellaneous wrenches, fixings, etc.; some engineers (and especially firemen) will be hostile to any attempt at systematization, the more so where responsibility is involved; the roundhouse forces will be too busy to heed anything; and it will be found that the stores on different divisions carry articles for equipment varying in style or quality, that some things are manufactured in shops when they might be bought better and cheaper, or the reverse, that many articles are not the best or most serviceable or suitable (i.e. gauge lamps, or spring valve long oilers), that some things are carried uselessly while other items are lacking though needed, that the printed list is probably perfunctory and doesn't agree with the actual stock or with sundry circular letters of instruction. In other words the whole problem will be vexatious, inconsistent, confusing—apparently hopeless!

The committee named is a very broadly representative one, and not without reason, because this little subject has many deep ramifications. For instance, it is desired to "standardize" all the tool and seat boxes and lockers. Of course, this can be done only after the equipment has been decided upon, so that these boxes may conveniently contain each its proper outfit. It is at once found that the tenders are of all different classes and arrangements, and that it is almost impossible to get any "uniformly standard" method of placing boxes. The best that can be done is to have one, or perhaps two, alternative plans. Similarly attempts to standardize coal boards (for cheapness of manufacture, and convenience of keeping in stock and applying) meet the same difficulties. Locomotive cabs, it will be found, are equally fractious in exacting varying widths, heights or lengths to the boxes put in them. In designing "standard" types of locomotives (such as the Harriman common standard; or the Rock Island standard types), the matter of cab and tender arrangement should be considered by the mechanical engineer, and provision made for using standard equipment.

Again, as fast as certain articles are recognized and adopted as "standard" equipment, a drawing and full description should be made of same, it is then definite, and may be referred to by number. This feature also comes under the mechanical engineer.

Some one suggests a uniform bracket for all classification or signal lights, on cars and cabooses as well as on engines and tenders—suggests furthermore a uniform style of lamp, adaptable instantly to either right or left, and, being composed of white (the cheapest) lenses, changeable by means of colored glass slides or tin blanks to any system of color signals desired. This proposition cannot be worked out without the advice and consent of your superintendent.

Before any actual organization is attempted, these matters of standard equipment, and the main plan of the checking and accounting system, should be determined upon, drawings made, quotations and samples asked of the purchasing agent, and orders placed (these orders should be quite aside from the regular monthly requisitions, until the equipment is in service—though of course, the requisitions should conform to the standard articles, a detail which your equipment inspector should very carefully watch out for, and correct, before the requisitions are sent up for approval). For it does not pay to try one thing, then switch over onto something else, and so add to the confusion at the very start. The preliminary preparation and development of this system may well take from 2 to 4 months or even 6; that is it may well be this length of time before a single tool is placed on an engine under the new arrangements. But it will be time of gathering information as to tender dimensions, sizes of valve-stems (in service—not on blue-prints), of crank pins, of crank pin nuts, of making inventory of equipment in service, of stock in the stores, of sizing up the facilities for applying equipment on various divisions, of selecting men and familiarizing them with the duties of such equipping, etc.

It will be well if the equipment inspector can spend two or three weeks investigating practice in the roundhouse, on the road, and in the office records, on other railroads. The New York Central, the New Haven, and the Pennsylvania are profitable (and extensive) fields for such study. The time thus spent will be a paying investment, as it insures the best precedents being followed.

ITEMS WHICH SHOULD BE STANDARDIZED.

The following items, if used at all, should each be reduced to one uniform standard over the whole railroad:

Headlights and chimneys, lubricators, air signal hose, air brake hose, passenger; air brake hose, freight; steam hose, all hose and couplings between engine and tender, signal lamps and brackets, gauge lamps and brackets, water glass lamps, bell cording, wrecking chain, pinch bars, fusees (10-minute), torpedoes, valve stem clamps, medical boxes, emergency knuckle, ax, saw, water buckets, brooms, brushes, sponges and irons, water coolers, drinking cups, tripoli can, card holder, portable tool boxes, flags (size and quality), lanterns, fire-door chains, push poles and method of carrying; torches, seat box cushions, hooks, gauge cock drip trough, the various sizes of oil cans, coal picks, hand hammers, combination hammers, soft hammers, each size of screw, Stillson and alligator wrench, each style of chisel, set, punch, file, drift or scraper.

COST OF INSTALLING NEW SYSTEM.

An engine equipment will cost from $20 to $150. A very satisfactory one should be obtained for $50 to $60. The total "life" of this equipment, under first rate management, is estimated at from two to five years; in actual practice, without adequate organization, the "life" is but a few months. I know of a case where the full equipment of an engine was worth $65 complete, excepting the headlight. There were over 1,000 engines on the road. No one of them was completely equipped; most of them had less than one-third of what they should have had. Yet the annual requisitions for engine supplies alone totaled much over $70,000 (it was not practicable to get at records of articles made in shops), or more than the complete cost of an equipment for each engine every year; and even then the engines did not carry more than $20 worth of stuff at one time! The figures should have been about $25,000 for supplies, to which might be added from $10,000 to $15,000 to cover the cost of the inspectors, the "organization." And then the engines should have had each the full $65 equipment, all the time.

For a road of this size it would take nearly a year to work the problem out, and in that year perhaps $50,000 would be spent for *new* equipments, in addition to the current $25,000 (or probably a little more than $25,000 until the organization was completed); and as much as $30,000 might also be spent on "labor" (or "intelligence") or men to place boxes and equipment on engines, make record of and check same. This totals over $100,000, for the first year. The second year is, we have seen, only $40,000. In other words in two years, spending the same amount that we were spending ($70,000) to secure an average $20 equipment on an engine, we could secure a full, efficient and *economical* organization, have every engine running with an entire complement of supplies, and thereafter, while maintaining the same high standard, secure a net saving of $30,000 per year. I speak not from theory but from fact, from experience.

Reducing this to terms of one locomotive (and the railroad official may multiply by the number of his locomotives to get the gross figures) this means that whereas an engine may be running (and the condition is nearly average) with nominally a $65, but actually a $20 equipment, at a yearly cost of $65 to $90 (taking into account engines in shop), under proper management, with an investment cost of $100 to $130 for the first year, the subsequent total annual cost will be only $40 to $50 per engine—a net saving of $25 to $40 each year on an extra investment for one year of $35 to $40.

Were similar results attempted on a smaller scale, over a longer period of time, no doubt commensurate results could be secured. But the slower the time, the smaller the scale, the longer deferred are the savings—the longer continued are the wastes.

I have not space at this time to discuss what should be an ideal equipment to fit average conditions, treating each item separately, together with dimensions, costs, material, etc.; nor can I go into an exposition of the printed forms, method of keeping records of each engine and crew, method of ascertaining daily just what equipment is drawn from store, by whom, and where; I can do no more than give a brief outline of the way in which the problem may be approached, and add thereto a few suggestions. I have already proposed placing the matter in the hands of the superintendent of motive power, the appointment of an advisory committee of some importance, and the delegation of the execution of the plan to an equipment inspector. This individual has studied the essential features of practice on other roads and has made his report to the committee; our committee has at length resolved upon the full standard equipment, the general plan of organization, the latitude to be allowed to the inspector in carrying out the plan; our committee has also made its recommendations to the superintendent of motive power, as to the scale on which it is advisable to plunge into the venture—the "first year" investment in complete equipments, the number and rates of men placed on the various divisions with the special (and in many cases temporary) function of getting the system in operation; and the superintendent of motive power has taken the matter up with the general manager or other superior officer, and obtained his approval and authority for the move. It is as big a matter as that.

METHOD OF INSTALLING NEW SYSTEM.

The equipments, to the tune of $10,000 or $100,000, or more, or less, have arrived, and are in charge of the store department. They have been coming in, wrenches in one lot, oil cans in another, in various consignments for the past six weeks or more. Nothing of those new "standard" equipments has been issued, to be lost track of or misused.

What does our equipment inspector do? He selects two principal points on the main line, on the principal division, and equips the engines operating on the best trains between these two turning points. He has ridden with the engineers of these 2, 4, 8, 12 locomotives, has been friendly with them, has made them interested in the new plan, has (seemingly at least) listened to their suggestions, perhaps humors a whim or so, has made it plain that they are picked out as first to receive these brand-new equipments, as best able to demonstrate the success of the system.

At one of the turning points is a large store. At this point supplies are drawn and placed upon the engine all newly prepared as to boxes, locks, brackets, etc., and full record made of the equipment by a local inspector—one of the two or three or half dozen men who have been collecting data, making inventories, etc., on this very subject for a couple of months previous. He is breaking in an assistant. At the other end is another such inspector who has received a copy of the equipment list of each engine. So these two men, one at each end of the engines' run, watch like hawks for the appearance of the 2, or the 12, that have been equipped preliminarily, and are prompt to follow up any irregularity in the custody or use of articles upon them. It matters not in this connection whether the tools, etc., be locked in boxes on the engine, and there inspected or placed in a box and delivered at a tool or locker room over which the inspector presides—the general method is all the same. For handling a large volume of business the second method is undoubtedly the best.

A few days pass. These first few engines do not "lose" their equipment, though a few annoying circumstances come up. The "assistants"—new men broken in—take up the work; the experienced men are transferred to other points; still the policy of "main line," "best trains" is adhered to as it is easier to keep track of these engines. They are equipped, after the first two weeks or a month, say, at the rate of one engine a day per inspector employed. If there were one inspector employed for every 20 or 30 engines in service (this is for the "first year" only—afterwards it should be one for 40 or 50 engines) the thorough equipment should, theoretically, take only a month. But it will be longer. The branch lines will not be so easy to handle; the freight engines will cause no end of trouble; it will be difficult to secure proper material for inspectors, it will be slow at best "breaking them in." If the organization and the equipment is worked out in three or four months, the thing will have been well done. Then for a month or so the matter will be stationary, while it settles down to being the normal method of operation. Then the less efficient inspectors will be dropped, or transferred to other work—and behold! the system is complete, the ground-work is done! The equipment inspector will have to stay—or some one in his place, to be at the head of the organization, to maintain efficiency. But the capital expense ceases and the returns now come in. Is it not a subject worth at least consideration by more of our railroads?

A FEW USEFUL HINTS.

A few hints may be useful: Don't carry too much on the engine—it is meant to pull a load, not to contain one. Anything which is regularly carried on passenger or baggage coaches, or on cabooses (such as ax and saw, air and signal

hose, wrecking frogs, jacks, etc.), need not be carried on the engine, too.

State laws should be fulfilled.

Every article should be marked plainly with the company initials; the manufacturer is the best one to do this. And it might be well if a little detective work were done in locating company supplies in private homes, or junk shops; railroads are generally regarded as public benefactors and providers in this respect.

Remember that if you attempt to mark each article with an engine (or individual) number, or with the name of an engineer, you are going to have many difficulties, although such markings are perhaps more useful than troublesome.

Any list put up in the cab is bound to get dirty.

Light or cheap locks, and any but bolted hasps and hinges on locomotive boxes and lockers are worse than none, as they are easily (and usually) forced or broken. Get the best locks, or make some other arrangement for safeguarding equipment.

Hostlers should have hammer, torch and screw wrench of their own so they may have no occasion to use the engine crew's kit.

While whatever plan is deemed wisest and decided upon, should be carried out firmly and consistently, one should not be too particular in details in dealing with enginemen; one defeats one's purpose; one gains ill-will rather than co-operation.

There should be real penalties for intentional or careless violation of rules framed for the safeguarding treatment or use of the equipment.

Engineers should be brought to understand that efficient system in this matter is to their lasting assistance and convenience.

Equip all engines; there is then no excuse for stealing from one to the other.

Branch line engines will require more complete equipment than on the main line, being remote from large roundhouse facilities.

Freight engines will be poorest in equipment—and most difficult to keep in equipment, to inspect, to trace.

CRANK PIN AND AXLE CALCULATIONS.

The demand for the June, 1899, issue, containing the crank pin and axle calculations reduced to a "vest pocket basis" by Mr. L. R. Pomeroy has been so great that the article is reproduced here. Additions have been made to the two tables to cover the larger engines which have come into use since the article first appeared. The first table gives the value of the moment of resistance (0.0982 multiplied by the third power of the diameter) for diameters from 3 to 12⅞ ins., advancing by eighths; the second one gives the value of P (piston area times the boiler pressure) for various diameters of cylinders between 12 and 25 ins. and for varying pressures from 160 to 225 lbs. These tables are used in connection with the two diagrams, one giving the formula for calculating the size of the crank pins and the other for driving axles.

One of the large locomotive works has used these formulæ for several years, the method of applying them varying slightly from that above. For crank pins they limit the fibre stresses to 18,000 lbs. for steel and 15,000 lbs. for wrought iron. For simple locomotives the load (P) is taken as the area of the cross-section of the cylinder ½ in. larger in diameter times the boiler pressure. For compound locomotives P = the adhesive weight times the diameter of the drivers divided by 3.5 times the stroke, or P may be taken the same as for simple locomotives using the high-pressure cylinder. The pins are made ⅛ in. larger for wear, and the hub fit for the main pin is made at least ¼ in. larger than the intermediate bearing.

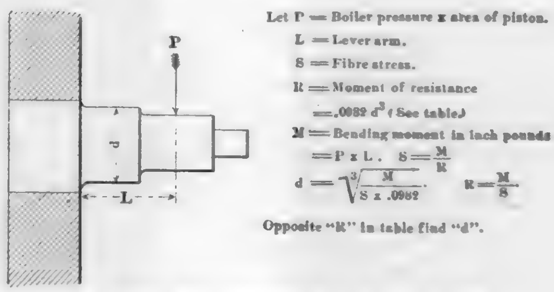


DIAGRAM AND FORMULAE FOR CRANK PINS

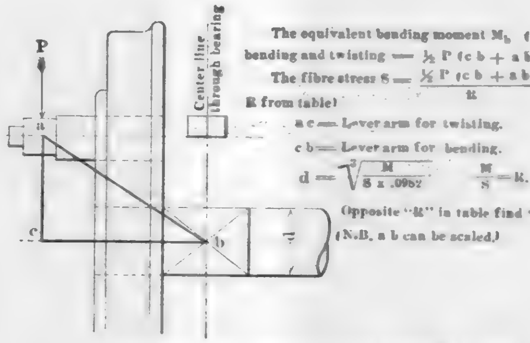


DIAGRAM AND FORMULAE FOR DRIVING AXLES

FIBRE STRESSES ALLOWABLE.

	Iron. Pounds.	Steel. Pounds.
Driving axles	18,000	21,000
Crank pins	12,000	15,000

MOMENT OF RESISTANCE, $R=0.0982\,d^3$.

	0	⅛ in.	¼ in	⅜ in.	½ in.	⅝ in.	¾ in.	⅞ in.
3 ins.	2.65	3.00	3.37	3.77	4.21	4.67	5.18	5.71
4 ins.	6.28	6.89	7.53	8.22	8.95	9.71	10.52	11.37
5 ins.	12.27	13.22	14.21	15.25	16.34	17.48	18.67	19.91
6 ins.	21.21	22.56	23 97	25.44	26.97	28.55	30.20	31.91
7 ins.	33.68	35 52	37.42	39.39	41.43	43.53	45.71	47.96
8 ins.	50.28	52.66	55.14	57.68	60.30	63.01	65.78	68.64
9 ins.	71.59	74.61	77.72	80.91	84.19	87.56	91.01	94.56
10 ins.	98.20	101.92	105.74	109.66	113.67	117.78	121.99	126.29
11 ins.	130.70	135.20	139.82	144.53	149.34	154.26	159.30	164.44
12 ins.	169.69	175.04	180.51	186.09	191.79	197.60	203.53	209.58

VALUE OF "P."

CYLINDER DIAMETER INS.	AREA SQ. INS.	PISTON AREA BY BOILER PRESSURE.													
		160 LBS.	170 LBS.	180 LBS.	185 LBS.	190 LBS.	195 LBS.	200 LBS.	205 LBS.	210 LBS.	215 LBS	220 LBS	225 LBS.
12	113.1	18,096	19,227	20,358	20,923	21,489	22,054	22,620	23,185	23,751	24.316	24,882	25,447
14	153.9	24,624	26,163	27,702	28,471	29,241	30,010	30,780	31,549	32.319	33,088	33,858	34.627
16	201.0	32,160	34,170	36,180	37,185	38,190	39,195	40,200	41,205	42,210	43,215	44,220	45,225
17	226.9	36,304	38,573	40,842	41,976	43,110	44,245	45,380	46,514	47.649	48,783	49,918	51,052
18	254.4	40,704	43,248	45,792	47,064	48,336	49,608	50,880	52,152	53,424	54,696	55,968	57,240
18½	268.8	43,008	45,696	48,384	49,728	51,072	52,416	53,760	55,104	56,448	57,792	59,136	60,480
19	283.5	45,360	48,195	51,030	52,447	53,865	55,282	56,700	58,117	59,535	60,952	62,370	63,787
19½	298.6	47,776	50,762	53,748	55,241	56,734	58,227	59,720	61,213	62,706	64,199	65,692	67,185
20	314.1	50,256	53,397	56,538	58,108	59,679	61,249	62,820	64,390	65,961	67,531	69,102	70,672
20½	330 0	52,800	56,100	59,400	61,050	62,700	64,350	66,000	67,650	69,300	70,950	72,600	74,250
21	346.3	55,408	58,871	62,334	64,065	65,797	67,528	69,260	70,991	72,723	74,454	76,186	77,917
21½	363.0	58,080	61,710	65,340	67,155	68,970	70,785	72,600	74,415	76,230	78,045	79,860	81,675
22	380.1	60,816	64,617	68,418	70,318	72,219	74,119	76,020	77,920	79,821	81,721	83,622	85,522
22½	397.6	63,616	67,592	71,568	73,566	75,544	77,532	79,520	81,508	83,496	85,484	87,472	89,460
23	415.4	66,464	70,618	74,772	76,849	78,926	81,003	83,080	85,157	87,234	89,311	91,388	93,465
23½	433.7	69,392	73,729	78,066	80,234	82,403	84,571	86,740	88,908	91,077	93,245	95,414	97,582
24	452 4	72,384	76,908	81,432	83,694	85,956	88,218	90,480	92,742	95,004	97,266	99,528	101,790
25	471.4	75,424	80,138	84,852	87,209	89,566	91,923	94,280	96,637	98,994	101,351	103,708	106,065

VAUCLAIN 4-CYLINDER BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

On page 329 of our September issue the standard Atlantic type locomotive of the Rock Island System was described. The Baldwin Locomotive Works have just completed two Vauclain 4-cylinder balanced compound Atlantic type locomotives, which as far as possible are equipped with the Rock Island standard parts, although in redesigning the engines the builders were given full latitude in every particular which would contribute to the success of the design. These engines will be put in service on the Illinois division, which is a very busy one, and will be very carefully tested out in comparison with the large order of standard Atlantic type engines. Comparing the dimensions of the simple and the compound locomotives, it will be noted that the weight on drivers is slightly greater, and the total weight is considerably greater for the compound. The wheel base also varies slightly, while the steam pressure is 35 lbs. greater; the diameter of the first ring in the boiler is slightly smaller, although the heating surface and the grate area are considerably larger.

These engines have about the same tractive power as the Vauclain 4-cylinder balanced compound locomotive of the same type for the New York Central which was described on page 109 of the April, 1905, issue, and have about 4,000 lbs. less tractive power than similar locomotives for the Erie Railroad which were described on page 177 of our May, 1905, issue. The leading dimensions are as follows:

4—4—2 TYPE VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	24,000 lbs.
Weight in working order	199,400 lbs.
Weight on drivers	105,540 lbs.
Weight on leading truck	51,780 lbs.
Weight on trailing truck	42,080 lbs.
Weight of engine and tender in working order	about 340,000 lbs.
Wheel base, driving	6 ft. 10 ins.
Wheel base, rigid	16 ft. 2 ins.
Wheel base, total	30 ft. 3 ins.

RATIOS.

Tractive weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ heating surface	546
Heating surface ÷ grate area	63.9
Total weight ÷ tractive effort	8.3

CYLINDERS.

Kind	Compound.
Diameter and stroke	15 and 25 by 26 ins.
Valves	Balanced Piston.

WHEELS.

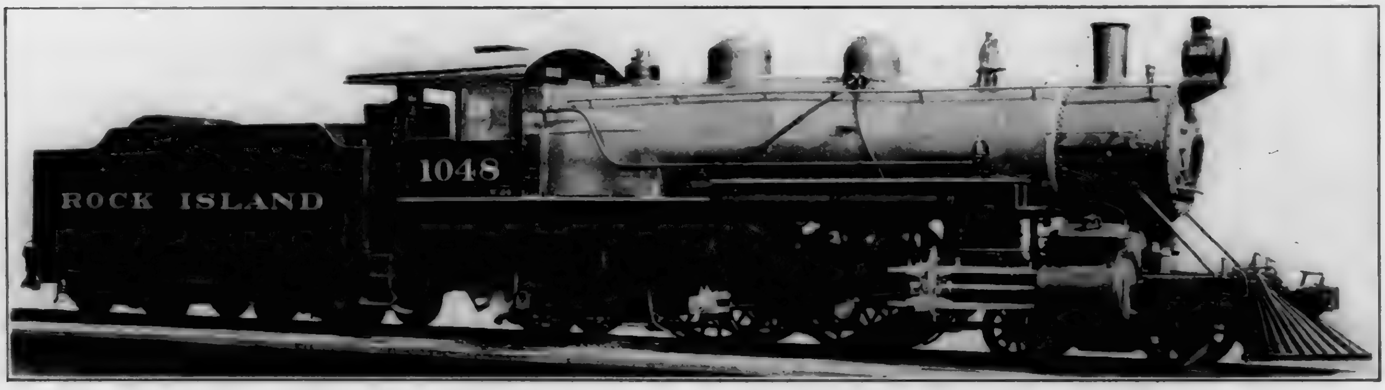
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3½ ins.
Driving journals, front, diameter and length	10 by 10½ ins.
Driving journals, back, diameter and length	9 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.

BOILER.

Style	Wagon top.
Working pressure	220 lbs.
Outside diameter of first ring	66 ins.
Firebox, length and width	107 9-16 by 67¼ ins.
Firebox depth	front, 78½ ins.; back, 66 ins.
Firebox plates, thickness	⅜ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	273, 2¼ ins.
Tubes, gauge and length	11, 18 ft. 10 ins. long.
Heating surface, tubes	3,015 sq. ft.
Heating surafce, firebox	194 sq. ft.
Heating surface, total	3,209 sq. ft.
Grate area	50.2 sq. ft.
Centre of boiler above rail	107 ins.

TENDER.

Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.



VAUCLAIN 4-CYLINDER BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

PROVISION FOR END SHOCKS IN CAR FRAMING.

BY A. STUCKI, M.E.*

With the introduction of high-capacity cars and the increasing demand for a maximum revenue for money expended in rolling stock, car building has just as much become a theoretical problem as building of locomotives, bridges, machinery, etc. The main object is the carrying of as great a load as possible on a car made as light as possible, consistent with proper strength. This point is generally understood and usually receives the attention it deserves, and the matter was greatly simplified when the M. C. B. Association adopted some standard loads as a basis for the construction of the cars and the interchange between adjoining roads. The car specification, the governing guide between owner, user and builder of the car, always mentions the load which is to be carried and, as a rule, gives the distribution of the load and the fibre stress due to such a static load, thereby defining every detail in this direction.

However, there are other strains coming on the car besides those just mentioned. They are always present when the car is in transit and are caused by what we may term "end shocks." These are very severe at times, and it is safe to say that by far the largest proportion of the damage is done by this class of strains. Notwithstanding this fact, no attempt has been made as yet to agree upon certain service conditions which the cars should be required to meet, and which also could be used as a basis in handling the cars in the yards and the trains on the road, and it is the aim of this paper to indicate a general outline, along which a solution of this whole problem seems practicable, and it will especially deal with the following points: Present service conditions; present car equipment; advantages of a standard to regulate both; best basis for such a standard.

PRESENT SERVICE CONDITIONS.

Owing to the general introduction of the automatic couplers, of longer trains, higher speed, heavier cars and heavier locomotives, the end shocks in service have gradually increased year by year. Complete data as to just what they amount to is, however, not at hand as yet, but we know approximately what strains are created in certain trains handled in certain ways. For instance, the drawbar pull of a heavy locomotive

*Paper read before the Railway Club of Pittsburgh.

of to-day may be considered to be 50,000 lbs. Tensile strains between the cars in long trains, handled carefully, may be regarded as 50,000 lbs.; handled ordinarily, 80,000 lbs., and handled roughly, 100,000 lbs., while the buffing strains can be considered 100,000, 150,000 and 200,000 lbs., respectively. In fact, in a great many cases this figure exceeds 300,000 lbs. In reality there is no limit and no established line as yet whereby a shock can be classified as a service condition or as an accident. (For further figures see the proceedings of the Western Railway Club of May 20, 1902, showing the results of extensive tests made by a committee of which Mr. W. H. Marshall was chairman.) These figures were obtained by the use of a dynamometer car and therefore are reliable as far as they go, inasmuch as the actual condition of the tracks, the locomotive, the draft gear and the stiffeners of the car frame are all taken care of. In fact, there is no other practical way of obtaining correct information on this subject. Since the above tests were made, the writer is not aware of any additional ones carried on in a systematic way.

The question is very important, since in the interchange of cars, 60,000, 80,000 and 100,000 lb. equipment is intermixed in long trains, which means that light constructions and heavy ones are subjected to the same forces, or same end shocks, because the latter, once set up, are actually the same, no matter what the capacity of the car may be. Wooden cars are run between those built of steel, with occasional results well known to us.

PRESENT CAR EQUIPMENT.

Although the entire train is practically subjected to the same end shocks a great difference in strength may be found in the equipment. A good spring draft rigging has now a capacity of about 40,000 to 60,000 pounds and a friction draft gear of possibly 180,000 lbs. The cross sectional area of a shank on a steel coupler is about 12 square inches, while the center sills of one of the hopper cars, a great many of which have been built, have a cross sectional area of 11.31 sq. in. In addition to this, the diagonal braces amount to 1.14 sq. in. in the line of the center sills. This makes a total cross sectional area of 12.45 sq. in. per car. The offset between the center of the coupler and the center of sills amounts to 2½ in., and the body bolster tie-plates have not been figured as assisting the diagonal braces. These cars give very good results in actual service, and if the elastic limit of the steel used is considered as 28,000 lbs. the actual results and the tests above referred to corroborate each other.

One of the large railway systems has recently increased this cross sectional area on hopper cars. On the tank cars, recommended by M. C. B. Association, 30 sq. in. are required in the center sills. In many cases no side sills exist and, the car frame being always as low as possible, there is actually little or no offset between the center of coupler and center of sills. In the cars with wooden underframes there is often a great deal of timber present, and the frequent failures are not at all due to a lack of timber, but are mostly due to the large offset between the center of coupler and center of sills, and also to the fact that a rational connection between the different timbers is almost impossible, and in the critical moments the bolts, instead of strengthening the underframe, tend to split and break up the timber.

A very large number of cars are built and equipped in such a way that it is not safe to run them in the long trains of to-day, and their strength is entirely inadequate for such a service. Many roads realize the danger due to this source and endeavor to protect themselves in making their new equipment to meet the worst conditions. Other roads do not think themselves justified in storing up so much material without getting any revenue from it; however, they are compelled to haul their neighbors' heavy cars without getting any additional compensation. It is also self-evident that their light equipment will have to act as yielding material for the heavier cars, in case the end shocks exceed the capacity of the draft riggings. A standard in this respect is an absolute necessity.

ADVANTAGES OF A STANDARD.

This would at once establish a line at which a car may be considered safe without wasting an excessive amount of material, a guide for those inclined to build strong, and a caution for those in favor of extremely light cars. On the other hand, it is plain that the damage to the rolling stock as a whole would be decreased enormously, first, on account of establishing a certain standard in handling cars and trains, and, secondly, in increasing the minimum strength of the train without increasing its tare weight. This, in turn, would mean: Less work on the repair tracks; greater average mileage per car in a given time; greater average revenue per car in a given time; greater average life per car.

I heard a superintendent of motive power remark the other day that no matter how well a new device is gotten up or how true its underlying principles are, it is not to be recommended unless it will show up on the right side of the balance sheet, and he is quite right. For this same reason a standard in this respect will enable the motive power and mechanical departments to determine whether a construction will really pay, or whether it may mean a loss in the end.

BEST BASIS FOR SUCH A STANDARD.

The next question is: "What should be adopted as a basis in determining the strength of a car lengthwise?" A.—Certain cross sectional area. B.—Certain fiber stress under a certain shock.

If the first plan is adopted it might be a comparatively easy matter, provided each type of car is treated separately. It would, for instance, not be fair to require the same cross sectional area for a gondola car as for a flat car, because the sills in the latter are already heavily strained by the load, while in many gondola cars the sills carry but a very small proportion of the lading. Great care would naturally have to be taken in compensating for the existing vertical offsets between the centers of couplers and sills.

If the latter plan is adopted, and it looks to me as if it should, the question may arise whether the car should be considered loaded or empty, when considering its resistance. Neither case would be correct, and each part of the car should be figured under those conditions which produce a maximum combined fiber stress. In most cases this will happen with the load applied; in some cases the fiber stress will be greatest on an empty car, and again there are cases where the load has no effect whatsoever upon the stresses under discussion. In pursuing this plan (one road entering Pittsburg has done this already) all that would be necessary is to agree upon a certain fiber stress under a certain shock. Inasmuch as these severe concussions fortunately do not occur often, the fiber stress, if produced by said shocks, can be allowed to be much higher than those brought about by the load alone. Such a plan of determining the longitudinal strength of the car has the advantage of being applicable to any type of car, no matter what the construction or the arrangement of the sills may be, and being based on the fiber stress it always discloses the real condition of the car. It may be claimed that this method is laborious. It is to a certain extent, but it only affects the designer who has to figure the different details anyhow, and the writing up of car specifications will be very much simplified. A few sketches will show how it can be figured quickly, and will also suggest in what direction we will have to work in order to get a strong car lengthwise, without unnecessarily increasing its weight.

Fig. 1 shows part of a hopper car. The conditions are very favorable, as the center sills are practically not strained by the load and are ready to exert their entire strength in taking the end shocks. The sills are 12 in. deep, lowered to come central with the coupler and to avoid an eccentric blow. By taking the 25 lb. channel we would get 14.70 sq. in., and counting on five rivets in each end of the diagonal brace passing through 5/16 in. material will amount to $2 \times 5 \times 13/16 \times 5/16 = 2.5$ sq. in. in two braces, and this will, considering the angularity of the braces, be equivalent to an additional cross sectional area in line of the car of 2.0 sq. in., giving a

VAUCLAIN 4-CYLINDER BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

On page 329 of our September issue the standard Atlantic type locomotive of the Rock Island System was described. The Baldwin Locomotive Works have just completed two Vauclain 4-cylinder balanced compound Atlantic type locomotives, which as far as possible are equipped with the Rock Island standard parts, although in redesigning the engines the builders were given full latitude in every particular which would contribute to the success of the design. These engines will be put in service on the Illinois division, which is a very busy one, and will be very carefully tested out in comparison with the large order of standard Atlantic type engines. Comparing the dimensions of the simple and the compound locomotives, it will be noted that the weight on drivers is slightly greater, and the total weight is considerably greater for the compound. The wheel base also varies slightly, while the steam pressure is 35 lbs. greater; the diameter of the first ring in the boiler is slightly smaller, although the heating surface and the grate area are considerably larger.

These engines have about the same tractive power as the Vauclain 4-cylinder balanced compound locomotive of the same type for the New York Central which was described on page 109 of the April, 1905, issue, and have about 4,000 lbs. less tractive power than similar locomotives for the Erie Railroad which were described on page 177 of our May, 1905, issue. The leading dimensions are as follows:

4-4-2 TYPE VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE
CHICAGO, ROCK ISLAND & PACIFIC RAILWAY

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	24,000 lbs.
Weight in working order	199,400 lbs.
Weight on drivers	105,540 lbs.
Weight on leading truck	51,780 lbs.
Weight on trailing truck	42,080 lbs.
Weight of engine and tender in working order	about 340,000 lbs.
Wheel base, driving	6 ft. 10 ins.
Wheel base, rigid	16 ft. 2 ins.
Wheel base, total	30 ft. 3 ins.

RATIOS.

Tractive weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ heating surface	546
Heating surface ÷ grate area	63.9
Total weight ÷ tractive effort	8.3

CYLINDERS

Kind	Compound.
Diameter and stroke	15 and 25 by 26 ins.
Valves	Balanced Piston.

WHEELS.

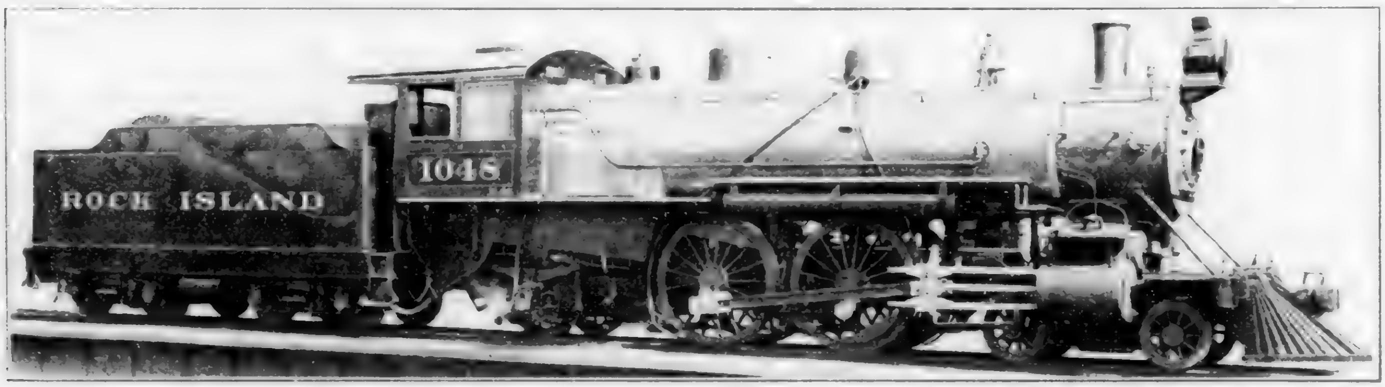
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3½ ins.
Driving journals, front, diameter and length	10 by 10½ ins.
Driving journals, back, diameter and length	9 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.

BOILER.

Style	Wagon top.
Working pressure	220 lbs.
Outside diameter of first ring	66 ins.
Firebox, length and width	107 9-16 by 67¼ ins.
Firebox depth	front, 78½ ins.; back, 66 ins.
Firebox plates, thickness	⅜ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	273, 2¼ ins.
Tubes, gauge and length	11, 18 ft. 10 ins. long.
Heating surface, tubes	3,015 sq. ft.
Heating surafce, firebox	194 sq. ft.
Heating surface, total	3,209 sq. ft.
Grate area	50.2 sq. ft.
Centre of boiler above rail	107 ins.

TENDER.

Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.



VAUCLAIN 4-CYLINDER BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

PROVISION FOR END SHOCKS IN CAR FRAMING.

BY A. STUCKI, M.E.*

With the introduction of high-capacity cars and the increasing demand for a maximum revenue for money expended in rolling stock, car building has just as much become a theoretical problem as building of locomotives, bridges, machinery, etc. The main object is the carrying of as great a load as possible on a car made as light as possible, consistent with proper strength. This point is generally understood and usually receives the attention it deserves, and the matter was greatly simplified when the M. C. B. Association adopted some standard loads as a basis for the construction of the cars and the interchange between adjoining roads. The car specification, the governing guide between owner, user and builder of the car, always mentions the load which is to be carried and, as a rule, gives the distribution of the load and the fibre stress due to such a static load, thereby defining every detail in this direction.

However, there are other strains coming on the car besides those just mentioned. They are always present when the car is in transit and are caused by what we may term "end shocks." These are very severe at times, and it is safe to say that by far the largest proportion of the damage is done by this class of strains. Notwithstanding this fact, no attempt has been made as yet to agree upon certain service conditions which the cars should be required to meet, and which also could be used as a basis in handling the cars in the yards and the trains on the road, and it is the aim of this paper to indicate a general outline, along which a solution of this whole problem seems practicable, and it will especially deal with the following points: Present service conditions; present car equipment; advantages of a standard to regulate both; best basis for such a standard.

PRESENT SERVICE CONDITIONS.

Owing to the general introduction of the automatic couplers, of longer trains, higher speed, heavier cars and heavier locomotives, the end shocks in service have gradually increased year by year. Complete data as to just what they amount to is, however, not at hand as yet, but we know approximately what strains are created in certain trains handled in certain ways. For instance, the drawbar pull of a heavy locomotive

*Paper read before the Railway Club of Pittsburgh.

of to-day may be considered to be 50,000 lbs. Tensile strains between the cars in long trains, handled carefully, may be regarded as 50,000 lbs.; handled ordinarily, 80,000 lbs., and handled roughly, 100,000 lbs., while the buffing strains can be considered 100,000, 150,000 and 200,000 lbs., respectively. In fact, in a great many cases this figure exceeds 300,000 lbs. In reality there is no limit and no established line as yet whereby a shock can be classified as a service condition or as an accident. (For further figures see the proceedings of the Western Railway Club of May 20, 1902, showing the results of extensive tests made by a committee of which Mr. W. H. Marshall was chairman.) These figures were obtained by the use of a dynamometer car and therefore are reliable as far as they go, inasmuch as the actual condition of the tracks, the locomotive, the draft gear and the stiffeners of the car frame are all taken care of. In fact, there is no other practical way of obtaining correct information on this subject. Since the above tests were made, the writer is not aware of any additional ones carried on in a systematic way.

The question is very important, since in the interchange of cars, 60,000, 80,000 and 100,000 lb. equipment is intermixed in long trains, which means that light constructions and heavy ones are subjected to the same forces, or same end shocks, because the latter, once set up, are actually the same, no matter what the capacity of the car may be. Wooden cars are run between those built of steel, with occasional results well known to us.

PRESENT CAR EQUIPMENT.

Although the entire train is practically subjected to the same end shocks a great difference in strength may be found in the equipment. A good spring draft rigging has now a capacity of about 40,000 to 60,000 pounds and a friction draft gear of possibly 180,000 lbs. The cross sectional area of a shank on a steel coupler is about 12 square inches, while the center sills of one of the hopper cars, a great many of which have been built, have a cross sectional area of 11.31 sq. in. In addition to this, the diagonal braces amount to 1.14 sq. in. in the line of the center sills. This makes a total cross sectional area of 12.45 sq. in. per car. The offset between the center of the coupler and the center of sills amounts to 2½ in., and the body bolster tie-plates have not been figured as assisting the diagonal braces. These cars give very good results in actual service, and if the elastic limit of the steel used is considered as 28,000 lbs. the actual results and the tests above referred to corroborate each other.

One of the large railway systems has recently increased this cross sectional area on hopper cars. On the tank cars, recommended by M. C. B. Association, 30 sq. in. are required in the center sills. In many cases no side sills exist and, the car frame being always as low as possible, there is actually little or no offset between the center of coupler and center of sills. In the cars with wooden underframes there is often a great deal of timber present, and the frequent failures are not at all due to a lack of timber, but are mostly due to the large offset between the center of coupler and center of sills, and also to the fact that a rational connection between the different timbers is almost impossible, and in the critical moments the bolts, instead of strengthening the underframe, tend to split and break up the timber.

A very large number of cars are built and equipped in such a way that it is not safe to run them in the long trains of to-day, and their strength is entirely inadequate for such a service. Many roads realize the danger due to this source and endeavor to protect themselves in making their new equipment to meet the worst conditions. Other roads do not think themselves justified in storing up so much material without getting any revenue from it; however, they are compelled to haul their neighbors' heavy cars without getting any additional compensation. It is also self-evident that their light equipment will have to act as yielding material for the heavier cars, in case the end shocks exceed the capacity of the draft riggings. A standard in this respect is an absolute necessity.

ADVANTAGES OF A STANDARD.

This would at once establish a line at which a car may be considered safe without wasting an excessive amount of material, a guide for those inclined to build strong, and a caution for those in favor of extremely light cars. On the other hand, it is plain that the damage to the rolling stock as a whole would be decreased enormously, first, on account of establishing a certain standard in handling cars and trains, and, secondly, in increasing the minimum strength of the train without increasing its tare weight. This, in turn, would mean: Less work on the repair tracks; greater average mileage per car in a given time; greater average revenue per car in a given time; greater average life per car.

I heard a superintendent of motive power remark the other day that no matter how well a new device is gotten up or how true its underlying principles are, it is not to be recommended unless it will show up on the right side of the balance sheet, and he is quite right. For this same reason a standard in this respect will enable the motive power and mechanical departments to determine whether a construction will really pay, or whether it may mean a loss in the end.

BEST BASIS FOR SUCH A STANDARD.

The next question is: "What should be adopted as a basis in determining the strength of a car lengthwise?" A.—Certain cross sectional area. B.—Certain fiber stress under a certain shock.

If the first plan is adopted it might be a comparatively easy matter, provided each type of car is treated separately. It would, for instance, not be fair to require the same cross sectional area for a gondola car as for a flat car, because the sills in the latter are already heavily strained by the load, while in many gondola cars the sills carry but a very small proportion of the lading. Great care would naturally have to be taken in compensating for the existing vertical offsets between the centers of couplers and sills.

If the latter plan is adopted, and it looks to me as if it should, the question may arise whether the car should be considered loaded or empty, when considering its resistance. Neither case would be correct, and each part of the car should be figured under those conditions which produce a maximum combined fiber stress. In most cases this will happen with the load applied; in some cases the fiber stress will be greatest on an empty car, and again there are cases where the load has no effect whatsoever upon the stresses under discussion. In pursuing this plan (one road entering Pittsburg has done this already) all that would be necessary is to agree upon a certain fiber stress under a certain shock. Inasmuch as these severe concussions fortunately do not occur often, the fiber stress, if produced by said shocks, can be allowed to be much higher than those brought about by the load alone. Such a plan of determining the longitudinal strength of the car has the advantage of being applicable to any type of car, no matter what the construction or the arrangement of the sills may be, and being based on the fiber stress it always discloses the real condition of the car. It may be claimed that this method is laborious. It is to a certain extent, but it only affects the designer who has to figure the different details anyhow, and the writing up of car specifications will be very much simplified. A few sketches will show how it can be figured quickly, and will also suggest in what direction we will have to work in order to get a strong car lengthwise, without unnecessarily increasing its weight.

Fig. 1 shows part of a hopper car. The conditions are very favorable, as the center sills are practically not strained by the load and are ready to exert their entire strength in taking the end shocks. The sills are 12 in. deep, lowered to come central with the coupler and to avoid an eccentric blow. By taking the 25 lb. channel we would get 14.70 sq. in., and counting on five rivets in each end of the diagonal brace passing through 5/16 in. material will amount to $2 \times 5 \times 13/16 \times 5/16 = 2.5$ sq. in. in two braces, and this will, considering the angularity of the braces, be equivalent to an additional cross sectional area in line of the car of 2.0 sq. in., giving a

total of 16.3 sq. in., which, under an end shock of 300,000 lbs., would produce a fiber stress of approximately 18,300 lbs. This seems to be a sufficient strength for an occasional shock, but it may be considered that for this type of car a greater end shock should be figured on as a basis, especially since in the coal trade the cars at times are exposed to a great deal of unreasonable punishment. It will be noticed that the height from top of rail to top of truck bolster is but 25¼ in., which is less than the height of the majority of the trucks now in existence; this height is of vital importance, and a change in this direction by the different roads would increase the life of the cars very materially and would also result in a standard height of truck, which in itself would be of great benefit to all concerned.

Fig. 2 shows an all-steel gondola car with 12 in. center sills. Since the car sides are expected to carry the load, the remarks made above apply here also, but in this case a larger portion of the end shocks will be transmitted to the sides of the car, so that all the material which runs continuously from body bolster to body bolster near the lower edge of the car sides is utilized. In this connection it is very important that the

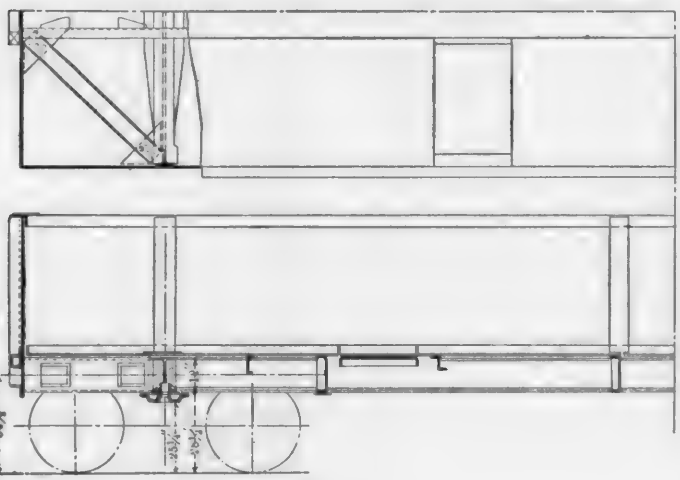


FIG. 2.

splices in the floor sheets and side sheets do not come in line, so as to get as much material as possible to act as a compression column, and the floor sheets near the center sills will also increase the strength in that direction. However, it will be borne in mind that these sheets are not continuous and are liable to be mutilated and partly destroyed in many ways.

Fig. 3 shows a sketch of a 100,000 lb. composite flat car. The center sill consists of a web plate, a cover plate, two top angles and four bottom angles. All members project through the body bolster and are supposed to be well connected with the draft rigging. Here the stresses will run comparatively higher than in the other type of cars, owing to the fact that the sills in the first place have to carry the load, and that the shocks under consideration will increase the fiber strains already present to an alarming degree. Most of the end thrust comes on the center sills. Only a small proportion is transmitted to the channel side sills by the diagonal braces, and the body bolster tie plates are not wide enough to materially enter into this function. The center of coupler is 1½ in. below the center of gravity of the sills at the bolster and 6 in. above the same in the center of the car. The combined maximum stress in the center sills at the body bolster is in the lower edge and is that due to the load, plus that due to the end thrust working on a 1½ in. offset. In the center of the car the maximum combined stress occurs in the upper edge and is that due to the load, plus that of the end shock working on a 6 in. offset. In case 15 in. rolled channels with the maximum offset are to be used, it would be desirous to drop the bottom of the center sills another 1⅓ in., which, in some cases, may be somewhat troublesome; however, with cast bolsters it can be done successfully. One of the eastern roads has gone much lower, but, as already said, this would not be possible with built-up bolsters. We have another means by which to drop the cars and to bring them in direct line with the coupler, this is a good design of a side-bearing truck, but, not having been tried out sufficiently, it would be premature to suggest the use of same at this time. The scope of this paper does not permit of going into the details of this important subject, and the writer has contented himself by presenting these few figures to illustrate the situation.

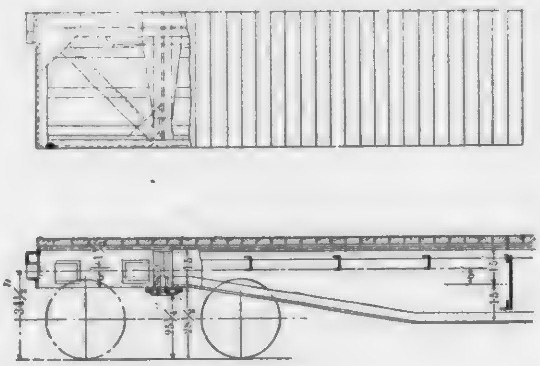


FIG. 3.

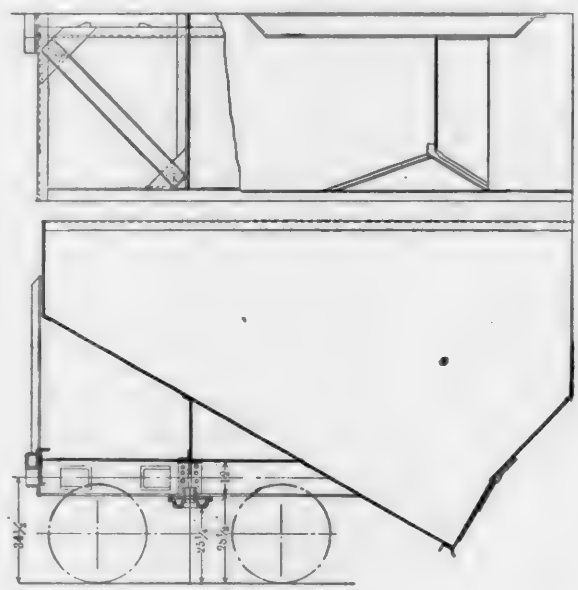
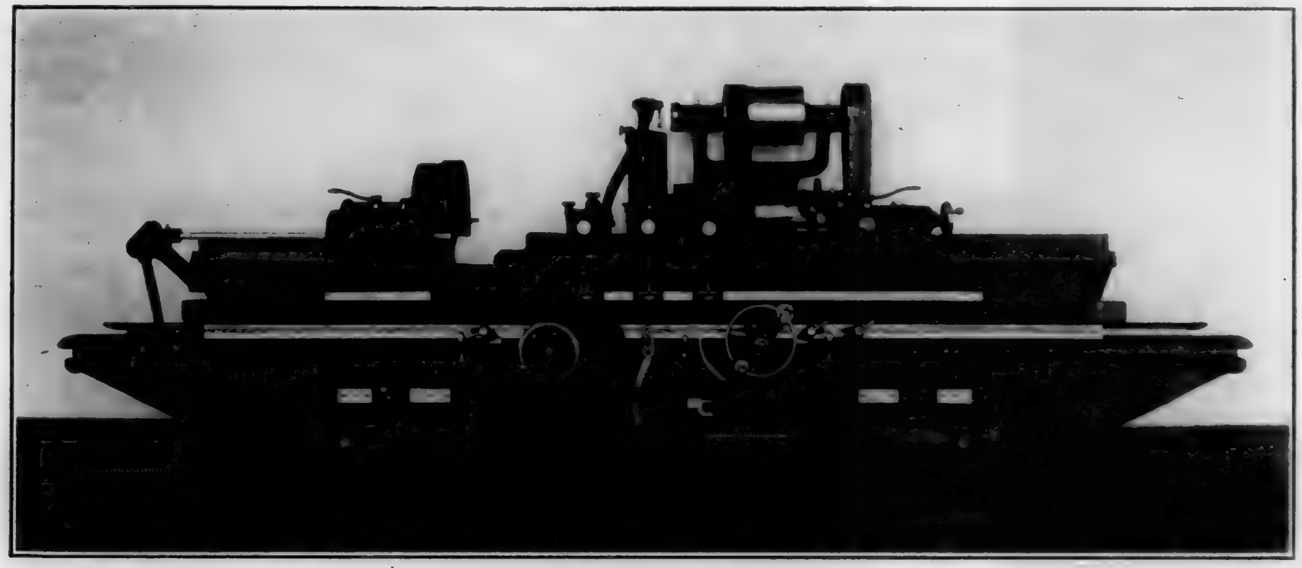


FIG. 1.

Importance of Knowing the Cost of Work.—One of the troubles in railroad shops, as compared with commercial institutions, is that the question of cost is largely lost sight of. Things are done in the shop because it is necessary to get them out immediately, without any delay, and almost regardless of expense. Very recently this matter was brought very strongly and clearly to my attention. A certain number of things had been made in a large shop, and after they had been made I went to the man who, of all others in the shop, ought to have known exactly how much they had cost. He took the paper covering these objects, looked them over carefully, and gave me an estimate of what these particular articles had cost in that particular shop. I took down the figures he gave me, and afterwards went over to the storekeeper and got the actual list and actual statement of the materials. His total was $1,430, and the real total was $5,841. Now, here was a man of good judgment and great skill and long experience, and yet in matters with which he was so well acquainted his judgment was as far astray as these figures indicated. The very first thing that is necessary in shop organization is to know what you are about; to know what things cost and what are the most important things, and the importance of this knowledge is not sufficiently brought to the attention of railroad shop employes.—*Mr. Harrington Emerson, before the Western Railway Club.*

MOTOR DRIVEN GAP GRINDING MACHINE.

It is doubtful if any one type of machine tool has received such thoughtful and careful study to adapt it for work in railroad repair shops as has the Norton gap grinding machine. The accompanying illustrations show a recent motor application to one of these machines. The drive is simple, compact and self-contained, and does not interfere with the passage of cranes. The operator, without moving from his position at the centre of the machine, may instantly change the speed at which the work revolves or stop the work regardless of where the head stock may be or of the length of the work; in fact, he has complete control of the operation of the machine from this point. A 10-h.p. constant speed motor of any make can readily be applied to one of these machines.



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This machine is specially adapted for grinding very heavy work, such as driving and truck axles and crank pins, or for grinding such work as valve stems, the yoke swinging in the gap, or for finishing piston rods, with or without the piston on, the piston swinging in the gap. Worn piston rods with the piston on may be ground smooth and true in from 15 to 20 minutes from the time they are lifted from the floor until they are replaced on the floor, and ordinarily this requires only an average of 6 h.p.; the careful construction and rigidity of the machine, and the fact that Alundum grinding wheels are used, making it possible to do the work with a comparatively small amount of power.

The machine will take work 8 ft. long and swings 18 ins., except in the gap, where the swing is 30 ins. The sliding ways are extraordinarily wide. A cast steel driving plate is used for the work drive. The revolving parts are carefully ground, and all rapid-moving journals are self-oiling and of high carbon steel. The machine weighs about 13,000 lbs..

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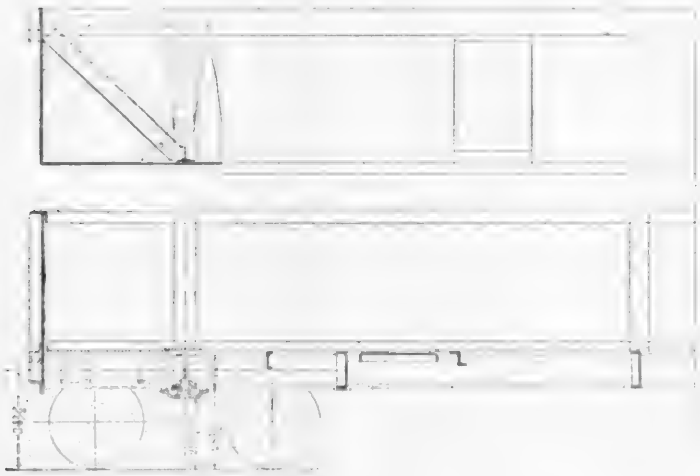

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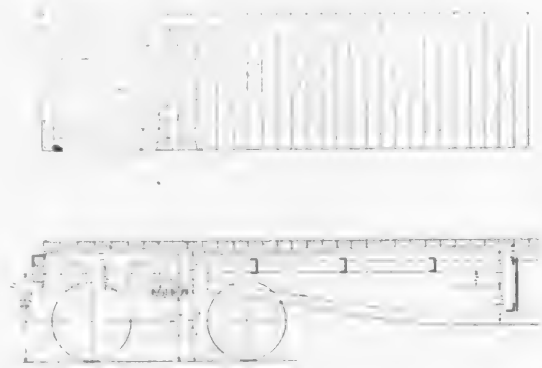

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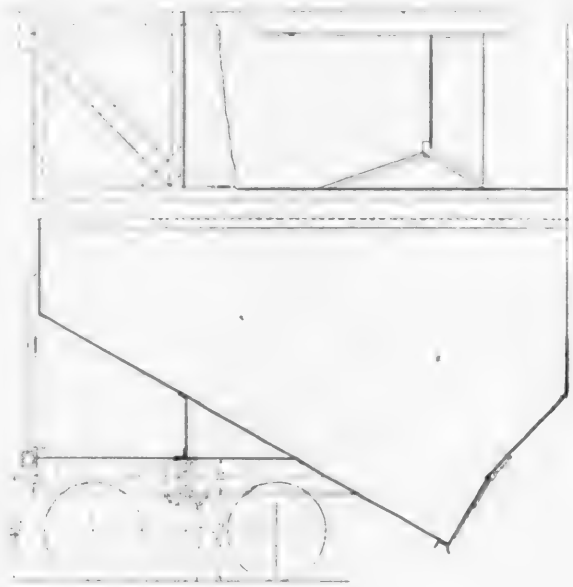

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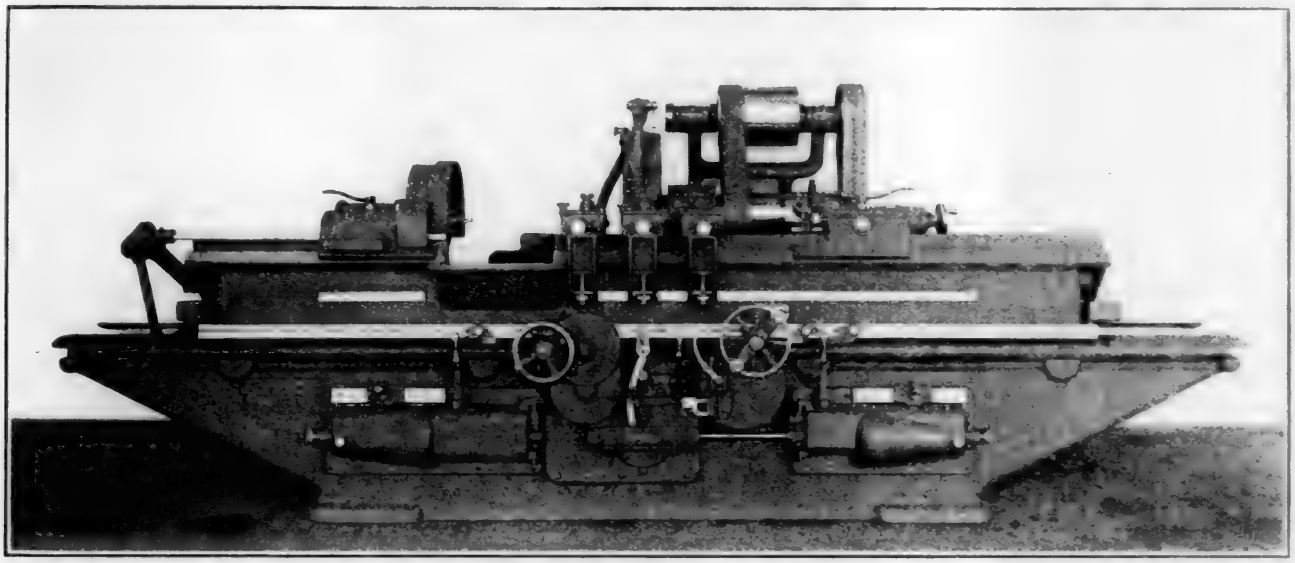

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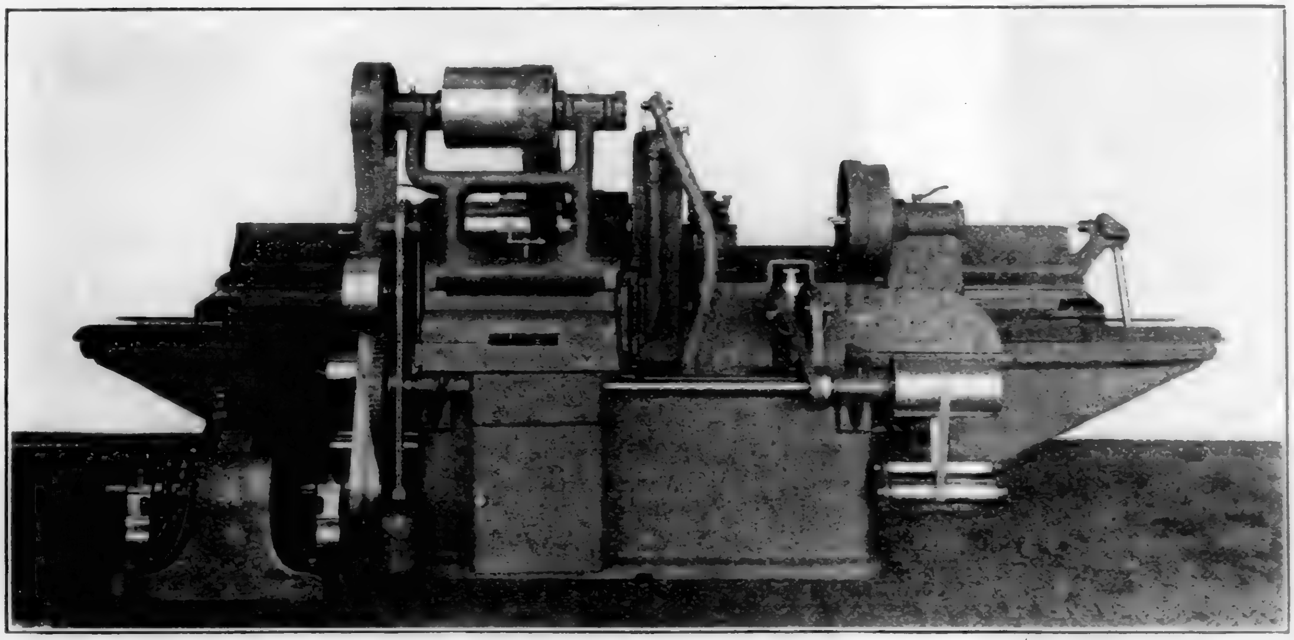

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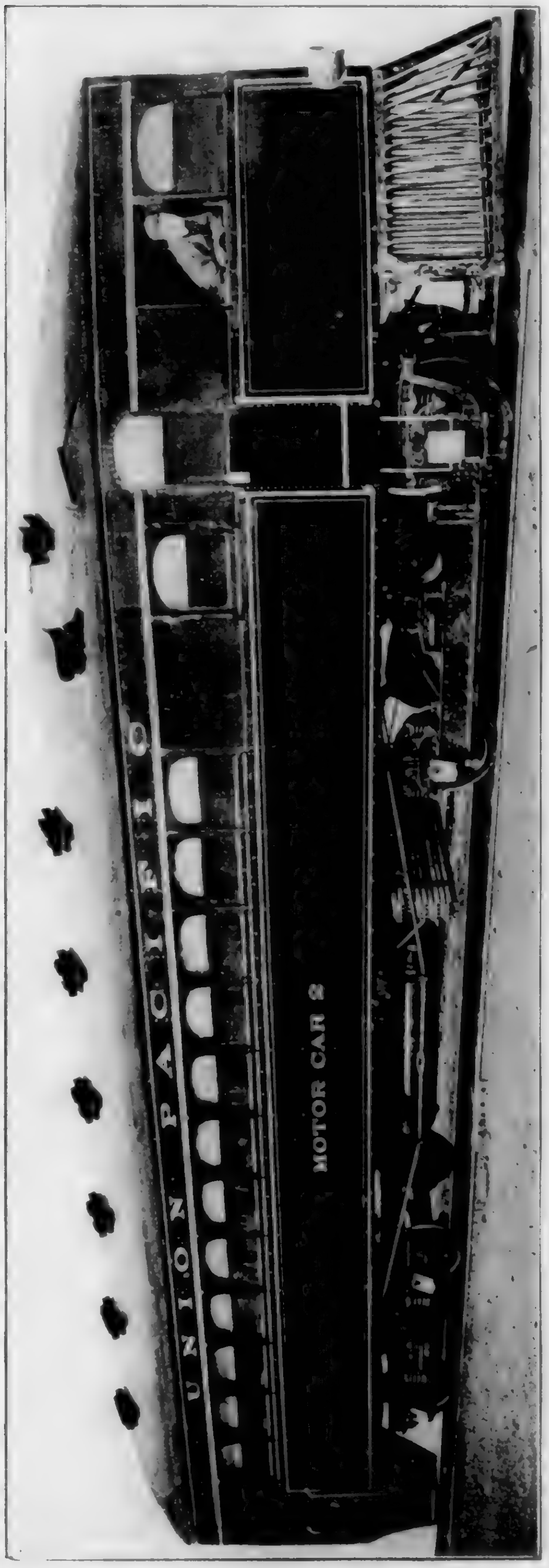
GASOLINE MOTOR CAR NO. 2.

UNION PACIFIC RAILROAD.

This car is considerably larger than car No. 1, which was described on page 294 of our August issue, and has several improvements which were suggested by the tests made with car No. 1. It is 55 ft. long, has two 4-wheel trucks, and seats 57 passengers. It is of the same general design as car No. 1, is of steel construction throughout, and is said to be exceedingly strong for its weight. The car weighs 56,000 lbs., although it is expected that additional cars which are to be built will not exceed 50,000 lbs., as it was very difficult to obtain proper material, and heavier parts were used than necessary.



GASOLINE MOTOR CAR NO. 2—UNION PACIFIC RAILROAD COMPANY.

The car is driven by a 100 h.p. 6-cylinder gasoline engine, designed especially for this purpose. It has a "make and break" spark ignition, with a primary battery for starting and a magneto for regular running service. The lever which controls the metal clutch is operated by air, which is controlled by a specially designed operating valve, by means of which the car may be started at a slow speed and the engine disconnected or thrown into high speed at will. The driving wheels are 43 ins. in diameter, the other wheels are 34 ins., and all are of rolled steel.

The car is ventilated by means of Cottier suction ventilators. The circulating coils for cooling the gasoline engine are so arranged that during cold weather the fresh air supply for the passenger end of the car may be warmed by passing over them. The car is lighted by acetylene gas and the 25 panel lights are so arranged that while the lighting is very brilliant, it is of a mild and diffused character and not wearisome to the eye. The interior of the car is finished in antique mahogany with a cream white ceiling and decorated in gold and sepia.

The car has been in use since September 14 and is giving very satisfactory results. It accelerates rapidly and is capable of developing a high speed. It was built at the Omaha shops of the Union Pacific Railroad, under the supervision of Mr. W. R. McKeen, Jr., superintendent of motive power, who has invented and patented the important features of construction.

TREATMENT OF HIGH SPEED STEEL.

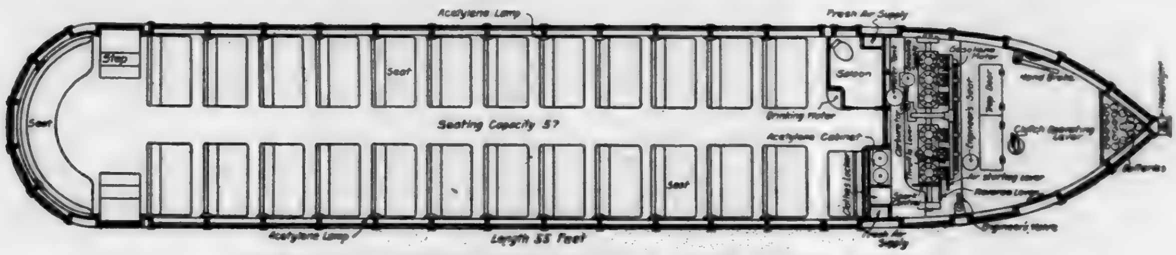
The following is taken from a paper read by Mr. R. A. Mould before the National Railroad Master Blacksmiths' Association:

There is no economy in purchasing a steel just because it is cheap, for with cheap steel we have the difficulties and trials that often arise, the result of which is lost labor and the destruction of an expensive tool. A better quality of steel may cost more in the beginning, but the outcome will be labor saved, because its superior lasting qualities and its ability to retain a cutting edge for long periods makes it the cheapest and most satisfactory. After having selected the grade required for the kind of work, I would recommend the striping of the bars with different colors of paint, then have a card

VIEW IN ENGINE ROOM, GASOLINE MOTOR CAR.

in the steel rack with brand and color corresponding to the color of paint upon the bars of steel. This will enable the workman to obtain the grade desired quickly, and with the certainty that he has the right grade. We can obtain from the steel manufacturer a card recommending the grade of steel as to carbon, in order to meet the requirements of the work, and I would call the attention of the convention to the importance of laying stress upon the instructions given us by the makers of tool steel. While many of us may have wide experiences in the manipulating of carbon steel, nevertheless the instructions given out by the makers have been obtained by the most trying and severe tests, and it is only when we ignore these instructions that we have trouble.

The causes of failure in using high-grade steel are numerous. In the first place, the steel may be overheated and overworked in forging, as most of our railroad shops heat their steel in open forges, and unless the greatest care is taken overheated edges and corners are the result. Then, while forging, it may be overworked. First, by working under a steam hammer of insufficient weight, so that the blows do not penetrate the center of the forging, causing piping, and, secondly, working the forging too cold while under the hammer, causing undue strains. When the tap, reamer, die or cutter is finished and comes to be hardened or tempered, the defects arising from the causes already mentioned will then demonstrate themselves, and will often result in the destruction of the tool.



FLOOR PLAN, GASOLINE MOTOR CAR NO. 2—UNION PACIFIC RAILROAD.

VIEW OF TRUCK, GASOLINE MOTOR CAR.

In order that our labors may bring success in the working of high-grade steel, there are three distinct stages or times of heating. First for forging, second for hardening, and, third, for tempering. The first requisite for a good heat for forging is a clean fire and plenty of fuel, so that jets of hot air will not strike the corners of the billet. Next, the fire should be regular, giving a uniform heat to the whole part to be forged. It should be keen enough to heat the billet as rapidly as possible, and allow a thorough heating. I would suggest the use of a furnace instead of a forge, to avoid the defects mentioned above, the overheating of corners. We should avoid high heating, as the steel cannot be returned to its refined condition unless we have a heavy steam hammer at our command, and sufficient stock in our billet, since heavy forging refines the bars as they slowly cool.

The second stage of heating for hardening requires great care: First, to protect the cutting edges and working parts from heating more rapidly than the body of the tool, and, secondly, the whole to be hardened must be heated uniformly. A uniform heat, as low as will give the required hardness, is the best to insure success. Bear in mind that every variation of heat which is great enough to be noticed will result in a variation of the grain, and the tool may be ruined by inattention to this point. The effect of high heat is to open the grain, making the steel coarse. The effect of an irregular heat is irregular grains, strains and cracks. As soon as a tool is heated it should be thoroughly quenched in plenty of cool bath—water, brine or oil—such as the case may be. An abundance of cooling bath to do the work quickly and uniformly is very necessary to good and safe work. To cool a large tap, reamer, die or cutter, a running stream should be used.

For the third stage of heating, the first important requisite is again uniformity: the next is time. The more slowly a tool is brought down to its temper, the better and safer is the operation. When such tools as taps, reamers, cutters and other expensive tools are to be made, it is a wise precaution to try small pieces of steel at different tempers, so as to find out at how low a heat the required hardness can be obtained. The steel should be of sufficient carbon and uniformity of quality to insure hardness at the lowest possible heat. The test costs nothing, takes but little time, and often saves considerable loss of time and expense.

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During the absence from Purdue University of the experimental locomotive, Schenectady No. 2, which is to be fitted with a Cole superheater, a New York Central Atlantic type engine is to be installed upon the testing plant for use under the direction of the Master Mechanics' committee on front ends. It is the purpose of this committee to repeat upon an engine of large size the experiments made under the patronage of the AMERICAN ENGINEER upon Schenectady No. 2, for the purpose of determining the constants in such equations as may be necessary to the logical design of all portions of the front-end mechanism. The Master Mechanics' committee having the matter in charge consists of Mr. H. H. Vaughan, superintendent motive power, Canadian Pacific Railway, chairman; Mr. F. H. Clark, general superintendent motive power, C., B. & Q. R. R.; Mr. Robert Quayle, superintendent motive power and machinery, C. & N. W. Railway; Mr. A. W. Gibbs, general superintendent motive power, Pennsylvania Railroad; Mr. W. F. M. Goss, Purdue University; Mr. G. M. Basford, American Locomotive Company.

WASTEFUL POWER PLANTS.—Very few railroad companies throughout the country know how much money they are wasting in power plants. There are a few railroad shops with up-to-date power plants, but I will venture to say that nine-tenths of them are behind the time and very wasteful. Some time ago I had occasion to look over a power plant with a view to determining what improvements were necessary, and found that the waste in fuel and labor alone amounted to over 10 per cent. on $180,000 every year. One hundred and eighty thousand dollars would build a strictly up-to-date power plant for a large shop.—*Mr. M. K. Barnum, before the Western Railway Club.*

GASOLINE MOTOR CAR NO. 2.

UNION PACIFIC RAILROAD.

This car is considerably larger than car No. 1, which was described on page 294 of our August issue, and has several improvements which were suggested by the tests made with car No. 1. It is 55 ft. long, has two 4-wheel trucks, and seats 57 passengers. It is of the same general design as car No. 1, is of steel construction throughout, and is said to be exceedingly strong for its weight. The car weighs 56,000 lbs., although it is expected that additional cars which are to be built will not exceed 50,000 lbs., as it was very difficult to obtain proper material, and heavier parts were used than necessary.

GASOLINE MOTOR CAR NO. 2—UNION PACIFIC RAILROAD COMPANY.

The car is driven by a 100 h.p. 6-cylinder gasoline engine, designed especially for this purpose. It has a "make and break" spark ignition, with a primary battery for starting and a magneto for regular running service. The lever which controls the metal clutch is operated by air, which is controlled by a specially designed operating valve, by means of which the car may be started at a slow speed and the engine disconnected or thrown into high speed at will. The driving wheels are 43 ins. in diameter, the other wheels are 34 ins., and all are of rolled steel.

The car is ventilated by means of Cottier suction ventilators. The circulating coils for cooling the gasoline engine are so arranged that during cold weather the fresh air supply for the passenger end of the car may be warmed by passing over them. The car is lighted by acetylene gas and the 25 panel lights are so arranged that while the lighting is very brilliant, it is of a mild and diffused character and not wearisome to the eye. The interior of the car is finished in antique mahogany with a cream white ceiling and decorated in gold and sepia.

The car has been in use since September 14 and is giving very satisfactory results. It accelerates rapidly and is capable of developing a high speed. It was built at the Omaha shops of the Union Pacific Railroad, under the supervision of Mr. W. R. McKeen, Jr., superintendent of motive power, who has invented and patented the important features of construction.

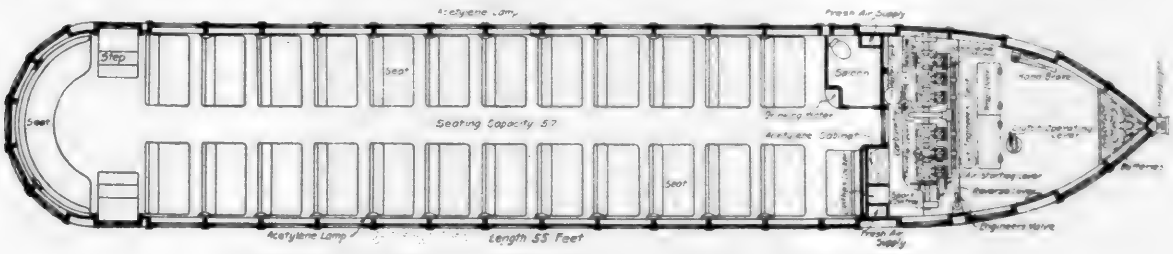
TREATMENT OF HIGH SPEED STEEL.

The following is taken from a paper read by Mr. R. A. Mould before the National Railroad Master Blacksmiths' Association:

There is no economy in purchasing a steel just because it is cheap, for with cheap steel we have the difficulties and trials that often arise, the result of which is lost labor and the destruction of an expensive tool. A better quality of steel may cost more in the beginning, but the outcome will be labor saved, because its superior lasting qualities and its ability to retain a cutting edge for long periods makes it the cheapest and most satisfactory. After having selected the grade required for the kind of work, I would recommend the striping of the bars with different colors of paint, then have a card

VIEW IN ENGINE ROOM, GASOLINE MOTOR CAR.

in the steel rack with brand and color corresponding to the color of paint upon the bars of steel. This will enable the workman to obtain the grade desired quickly, and with the certainty that he has the right grade. We can obtain from the steel manufacturer a card recommending the grade of steel as to carbon, in order to meet the requirements of the work, and I would call the attention of the convention to the importance of laying stress upon the instructions given us by the makers of tool steel. While many of us may have wide experiences in the manipulating of carbon steel, nevertheless the instructions given out by the makers have been obtained by the most trying and severe tests, and it is only when we ignore these instructions that we have trouble.



FLOOR PLAN, GASOLINE MOTOR CAR NO. 2—UNION PACIFIC RAILROAD.

The causes of failure in using high-grade steel are numerous. In the first place, the steel may be overheated and overworked in forging, as most of our railroad shops heat their steel in open forges, and unless the greatest care is taken overheated edges and corners are the result. Then, while forging, it may be overworked. First, by working under a steam hammer of insufficient weight, so that the blows do not penetrate the center of the forging, causing piping, and, secondly, working the forging too cold while under the hammer, causing undue strains. When the tap, reamer, die or cutter is finished and comes to be hardened or tempered, the defects arising from the causes already mentioned will then demonstrate themselves, and will often result in the destruction of the tool.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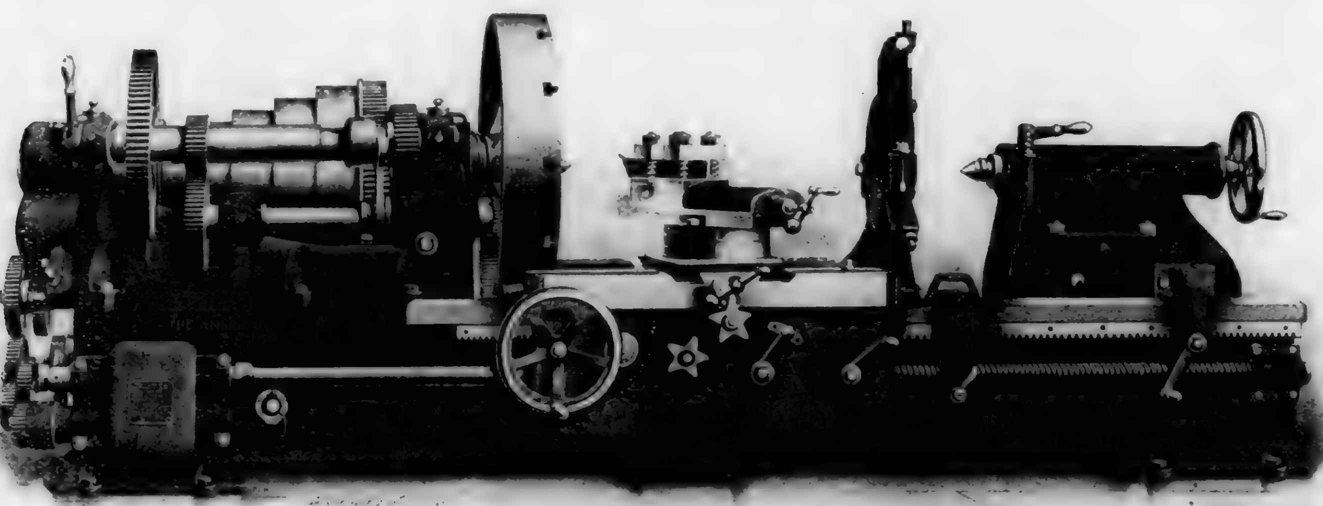
NEW HEAVY 36-INCH ENGINE LATHE.

The new heavy pattern 36-in. American engine lathe with triple-geared head, illustrated herewith, has several important improvements, including a quick change gear mechanism. This mechanism provides 32 changes for feeding and thread cutting, the range of threads being from one thread in 4 ins. to 16 threads per inch, including 11½ per in. pipe threads. The feeding range is 6.4 to 92 cuts per in. The device is operated by revolving the nut at the right of the gear box beneath the head, which moves a sliding key engaging two opposed gears, each being one of a cone of gears contained in the gear box. These changes may, if desired, be made while the lathe is in operation. The feed or screw pitches thus obtained are multiplied through the compound gears on the quadrant at the end of the head, it being necessary to change one gear only on the quadrant for each additional thread. This arrangement gives flexibility to the screw cutting mechanism, making it possible through the introduction of certain gears to cut an almost unlimited range of special worms or threads either finer or coarser than the range indicated above. Index plates show how to obtain any thread or feed.



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The tailstock base is rigidly clamped to the bed, and is also secured against movement by a pawl engaging the rack cast in the center of the bed. It has large continuous bearings on the ways, and may be moved rapidly along the bed by a crank and gear. The spindle has an exceptionally long travel.

The carriage is specially heavy at the bridge, due to the drop V bed, and has a continuous bearing of 50 ins. on the ways. The apron is double, giving all the shafts a double bearing. Both the longitudinal and cross feeds are reversed through a tumbler plate from the front of the apron, and this is a considerable advantage, especially on a long lathe. The top slide of the compound rest is provided with a power angular cross feed with 13½ ins. travel; the swivel is graduated and the top slide and cross feed screws have micrometer dials. The standard length of bed for this lathe is 12 ft., which takes 4 ft. 9 ins. between centers; it swings 38 ins. over the V and 26 ins. over the carriage. This lathe is made by the American Tool Works Company, of Cincinnati.

THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION.

The fourth annual convention of the National Machine Tool Builders' Association was held at the Hoffman House, New York City, October 16 and 17. This association consists of 45 members, as follows:

The Hendey Machine Co.	Torrington, Conn.
B. F. Barnes Co.	Rockford, Ill.
Detrick & Harvey Machine Co.	Baltimore, Md.
Baush Machine Tool Co.	Springfield, Mass.
P. Blaisdell & Co.	Worcester, Mass.
Draper Machine Tool Co.	" "
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F. E. Reed Co.	" "
Whitcomb Manufacturing Co.	" "
Woodward & Powell Planer Co.	" "
Norton Emery Wheel Co.	" "
Stockbridge Machine Co.	" "
C. E. Sutton Co.	Toledo, Ohio
Flather & Co., Inc.	Nashua, N. H.
Mark Flather Planer Co.	" "
Binsse Machine Co.	Newark, N. J.
Gould & Eberhardt	" "
W. P. Davis Machine Co.	Rochester, N. Y.
W. A. Wilson Machine Co.	" "
The American Tool Works Co.	Cincinnati, Ohio
Bradford Machine Tool Co.	Cincinnati, Ohio
Bickford Drill & Tool Co.	" "
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Greaves, Klusman & Co.	" "
Lodge & Shipley Machine Tool Co.	" "
R. K. Leblond Machine Tool Co.	" "
The King Machine Tool Co.	" "
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Rahn, Mayer Carpenter Co.	" "
Schumacher & Boye	" "
John Steptoe Shaper Co.	" "
Hamilton Machine Tool Co.	Hamilton, Ohio
Springfield Machine Tool Co.	Springfield, Ohio
Owen Machine Tool Co.	" "
Fairbanks Co.	" "
Jones & Lamson Machine Co.	Springfield, Vt.
The Ridgway Machine Tool Co.	Ridgway, Pa.
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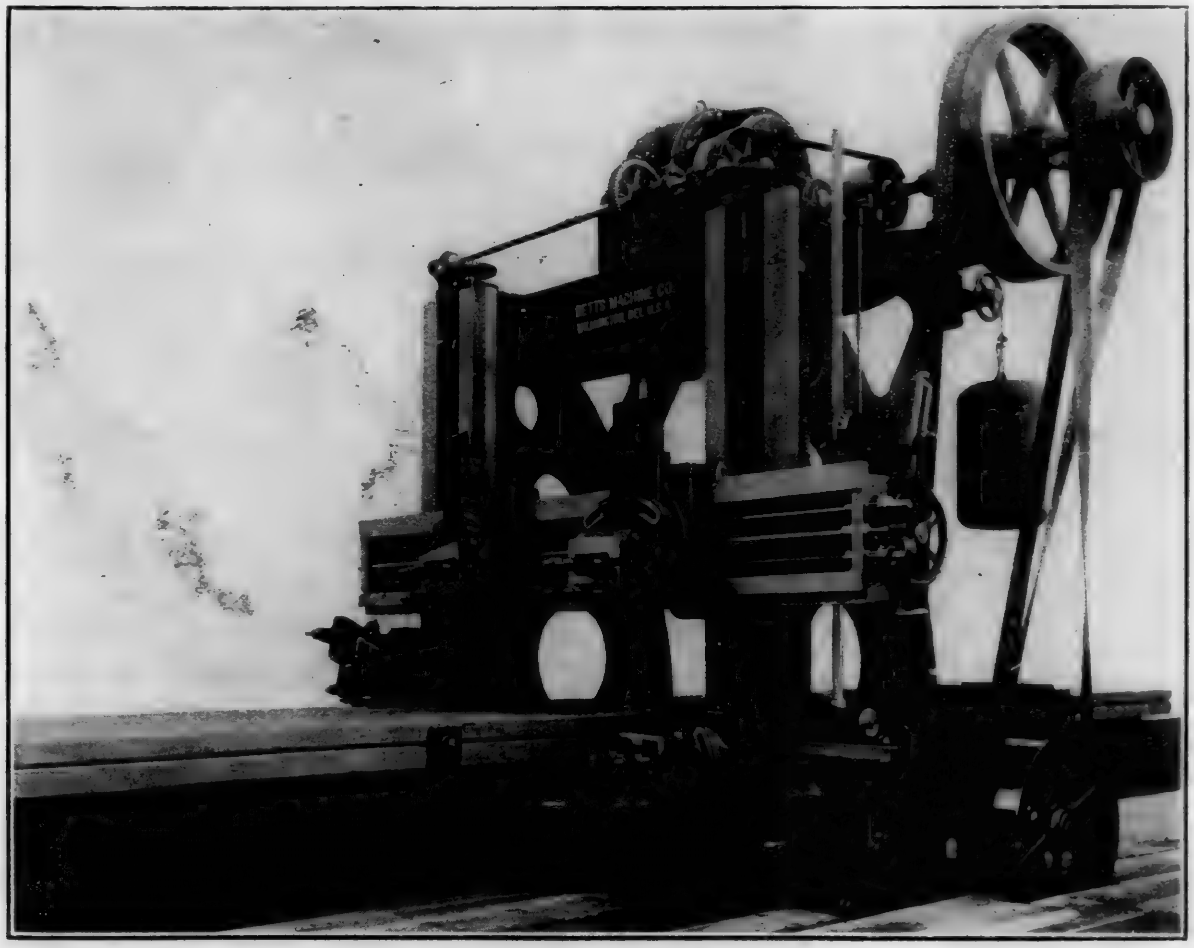
60 INCH MOTOR DRIVEN PLANER.

A 60-in. motor-driven planer has recently been installed at the C., C. & L. Railway shops at Peru, Ind., which has several interesting features. The table is of box section, thus making it very strong and rigid without undue weight; it is 54 in. wide and is driven by steel-cut gearing and a steel rack, and its motion may be controlled from either side of the machine. The driving force is transmitted through heavy sleeves instead of shafts, giving a smooth movement to the table. The machine will take work 61 in. in width and 61 in. high. The bed is well braced with cross girts of box form and the center of the bed through the gearing is of double-box section, making is especially strong at this point. The table V's are equipped with automatic lubricators.



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Positive feeds operate the tools at any angle in all four heads. The cross rail is of box-girder form with a deep arched back and is of sufficient length, when using two saddles, to permit of one head planing the entire width between uprights. The cross-rail feed adjustment is at the end of the rail, convenient to the operator. The elevating screws are both of the same hand, insuring parallism with each change of height. The uprights are of double-plate construction, making them very rigid for side cutting. The side heads are counterbalanced and have independent power feeds in either direction. They are of an extension-slide type, so that narrow angular side-head planing may be done at one setting. The tool holders are offset, enabling the two heads to plane close together. The tool clamp bolts slide in the apron, allowing the tool a wide range for adjustment.

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ELECTRIFICATION OF THE SPOKANE AND INLAND RAILWAY.

A contract has just been closed with the Spokane & Inland Railway Company by the Westinghouse Electric & Manufacturing Company, of Pittsburgh, for the equipment of an electric road, the present terminals of which will be Spokane, Wash., and Moscow, Idaho, 146 miles apart. The roadway is completed from Spokane to Waverly, a distance of 34 miles, and operation will be begun on this as soon as possible.

Each passenger car will be equipped with four 100-h.p. motors, capable of maintaining a schedule speed of 35 to 40 miles an hour. In the freight service four 150-h.p. motors will be used on each car. For the heavy freight service double locomotives, weighing, approximately, 70 to 80 tons, will be used, each consisting of two parts, and each part a complete 35 to 40-ton locomotive. Two or more of these locomotives may be coupled together and operated from the front cab as a single unit. The motor cars and locomotives will all be operated by the Westinghouse multiple unit control system. The motors will operate under three different conditions—6,600 volts alternating current in the interurban districts, 700 volts alternating current in the smaller towns, and 575 direct current in the city of Spokane.

In selecting the equipment for this road, both the alternating-direct-current and the single-phase systems were considered, but, after careful comparison, the single-phase alternating-current system was adopted. Not only did the estimates show a large saving in initial investments and in annual

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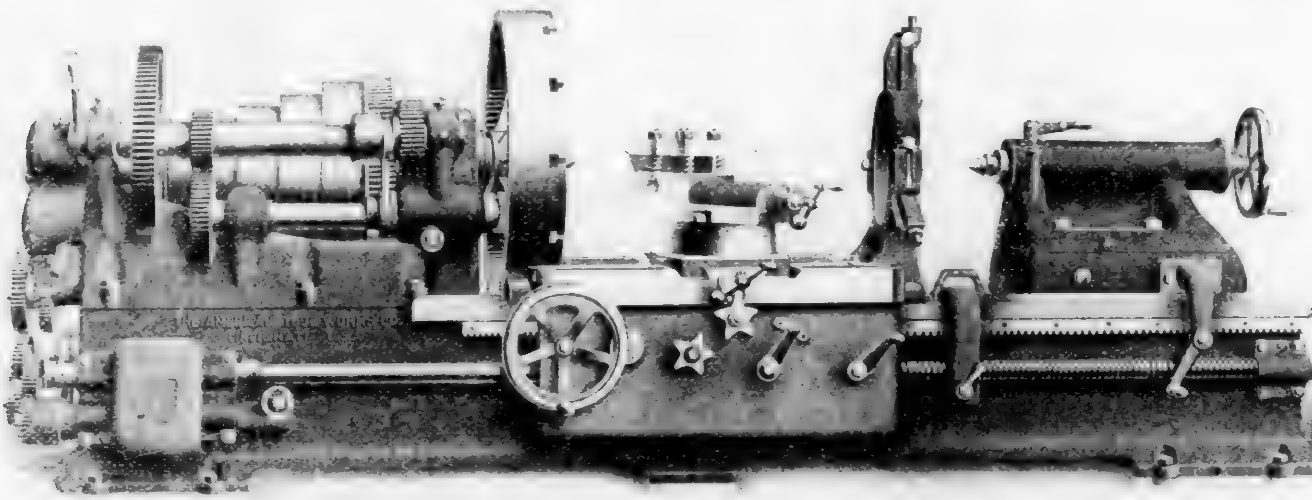

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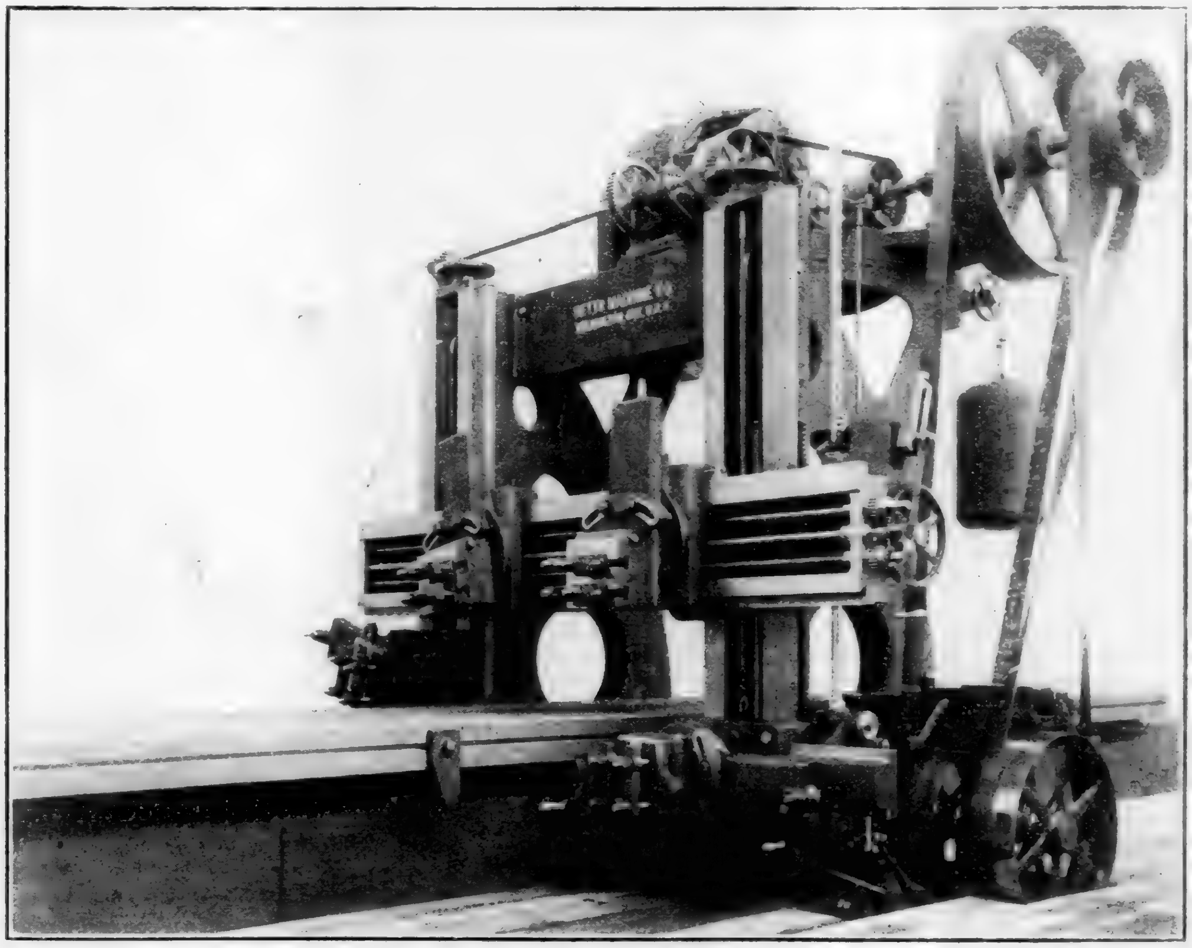

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ELECTRIFICATION OF THE SPOKANE AND INLAND RAILWAY.

A contract has just been closed with the Spokane & Inland Railway Company by the Westinghouse Electric & Manufacturing Company, of Pittsburgh, for the equipment of an electric road, the present terminals of which will be Spokane, Wash., and Moscow, Idaho, 146 miles apart. The roadway is completed from Spokane to Waverly, a distance of 34 miles, and operation will be begun on this as soon as possible.

Each passenger car will be equipped with four 100-h.p. motors, capable of maintaining a schedule speed of 35 to 40 miles an hour. In the freight service four 150-h.p. motors will be used on each car. For the heavy freight service double locomotives, weighing, approximately, 70 to 80 tons, will be used, each consisting of two parts, and each part a complete 35 to 40-ton locomotive. Two or more of these locomotives may be coupled together and operated from the front cab as a single unit. The motor cars and locomotives will all be operated by the Westinghouse multiple unit control system. The motors will operate under three different conditions—6,600 volts alternating current in the interurban districts, 700 volts alternating current in the smaller towns, and 575 direct current in the city of Spokane.

In selecting the equipment for this road, both the alternating-direct-current and the single-phase systems were considered, but, after careful comparison, the single-phase alternating-current system was adopted. Not only did the estimates show a large saving in initial investments and in annual

operating expenses in favor of the single-phase system, but a form of heavy traction is made possible, which would be practically unfeasible with the alternating-direct-current equipment. Besides the passenger traffic, the company is preparing to do a heavy freight business and also to carry mail and express.

NEW CARS FOR THE PENNSYLVANIA RAILROAD COMPANY.

The Pennsylvania Railroad Company announces that orders have been placed for 20,000 freight cars, all of 100,000 lbs. marked capacity. The box cars have steel under-frames, and are to be built to American Railway Association standard inside dimensions. Deliveries are to begin in March, 1906. The number of each class of cars to be built and the distribution of the orders is as follows:

	Lines East.	Lines West.	Total.
Pressed Steel Car Co.:			
Class GLa all steel self-clearing hopper gondola		2,500	
Class Gsd all steel gondola with drop bottom	5,500		
Class XL box car	4,000		
(1,000 to be built at works of Western Steel Car & Foundry Co.)			
Total	9,500	2,500	12,000
American Car & Foundry Co.:			
Class GLa		2,500	
Class XL	600		
Total			3,100
Standard Steel Car Co.:			
Class Gsd	2,000		2,000
Cambria Steel Co.:			
Class Gsd	2,500		2,500
Middletown Car Works:			
Class XL	400		400
Grand Total	15,000	5,000	20,000
Totals by Classes:			
Gsd			10,000
GLa			5,000
XL			5,000
			20,000

Location of Headlights.—In the matter of headlights, since locomotives began to grow to very large dimensions, something has apparently been forgotten and that is that as boilers grow larger, headlights, if placed in the usual location, go higher and higher until in the very largest locomotives of to-day, the height of the headlight is such as to render it practically ineffective, especially in the case of the ordinary variety using oil. In connection with the very large Mallet compound locomotive, built by the American Locomotive Company for the Baltimore & Ohio Railroad and illustrated in this journal in June, 1904, page 237, the location of the headlight was not mentioned, although this is clearly shown in the photograph. The headlight is dropped so that the board is 10 ft. from the rail, whereas if the headlight was put upon the top of the boiler, it would be nearly 14 ft. from the rail. While this is a very large locomotive and the headlight, if placed upon the boiler which is 84 ins. outside diameter, would be extraordinarily high, many locomotives of the present time are far to high for the usual location of the brackets. This matter has probably escaped the attention of many railroad officials and the practice of the Baltimore & Ohio seems to be worthy of wide acceptance.

NEW CARS FOR THE NEW YORK CENTRAL LINES.

Just as we go to press it is reported that the New York Central Lines have ordered 25,000 cars for 1906 delivery. The order is distributed as follows: The Pullman Company, 10,000; Haskell & Barker, 7,500; Pressed Steel Car Company, 3,000; Western Steel Car & Foundry Company, 2,000; American Car & Foundry Company, 2,500.

Electrification of the Erie.—It is reported that the advisability of electrifying districts where suburban traffic is heavy, also for use on the extreme grades between Susquehanna and Deposit, is under consideration.

LOCOMOTIVE AND CAR JOURNAL BEARINGS.

By means of specially formed bearings and the use of a special babbitt metal Mr. Albert C. Stiles, of the A. C. Stiles Anti-Friction Bearing Company, New Haven, Conn., claims to have solved the problem of locomotive and car journal lubrication. He also claims that with the proper quality of metal, the best lubricant and his method of lubrication no babbitt is required on a locomotive driving journal bearing.

The crown of the locomotive driving journal bearing, shown in Figs. 1 and 2, is formed with a longitudinal groove, from which passages lead transversely to longitudinal channels formed in the inner side of the bearing at points considerably removed from the crown. The lubricant is applied through the groove in the crown, and passes through the inner passages to the longitudinal channels at the side opposite to the direction in which the journal revolves, and is carried up

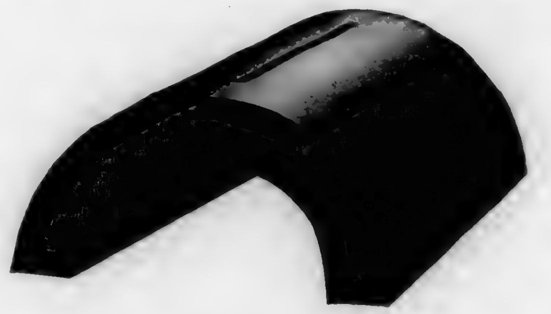


FIG. 2.

FIG. 1.

between the contact surfaces, lubricating the entire inner surface of the bearing. The usual oiling method provides a channel or oil holes feeding the lubricant at the crown of the bearing, and this causes two troubles; first, it weakens the bearing at the crown where the wear is the greatest; second, the journal fits closest and the pressure is greatest at this point, affording the least possible opportunity for the lubricant to feed, and by the time the journal has made three-quarters of a revolution very little lubricant is left on it. With the Stiles method of feeding from the side the oil is fed at a favorable point on the upper thrust, and is carried up over that part of the surface which is most important and most difficult to properly lubricate. If desired, oil channels may be placed on both sides, or the channel on one side may be filled with tallow, which will remain in place until the journal becomes hot, which might occur on account of neglect to furnish oil at the proper time. The tallow would supply lubricant for a time, thus preventing a hot journal.

The Stiles car journal bearing is shown in Fig. 3, and consists of a bronze shell made from a special formula, which is claimed to be of exceptional durability. The bearing of the bronze portion is of the same curvature as the journal, so

that in case the babbitt should be melted out the journal will find a perfectly fitted surface to run in. The method of babbitting is unique. The babbitt is much thicker than ordinarily used, and is interlocked with the shell as shown. The journal is so protected by the babbitt at the sides that it cannot wedge, and will not at any time touch the bronze except at that part which is prepared for its reception. As the bearing wears the journal rests in the bed fitted to it at all times, and even after the bronze shell has begun to wear the journal

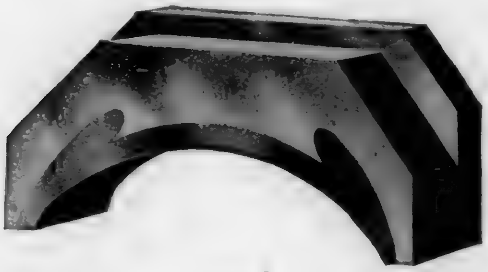


Fig. 3.

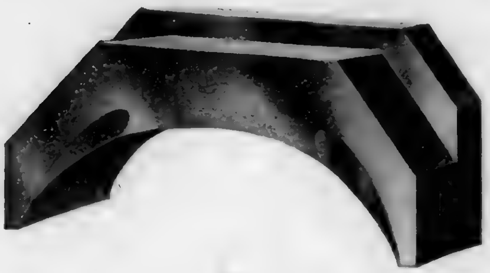


Fig. 4.

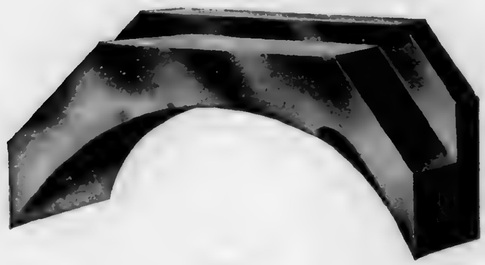


Fig. 5.

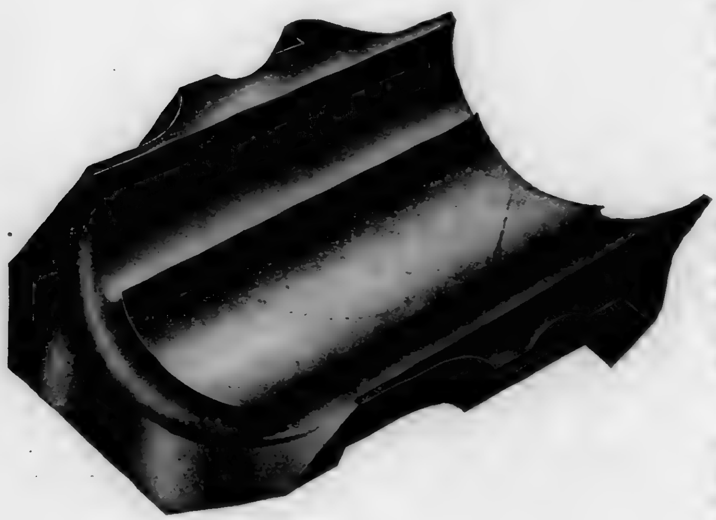


Fig. 6.

is fully protected, as may be seen by Figs. 4 and 5, the latter showing a bearing which ran 72,000 miles. The aim was to produce a babbitt bearing hard enough to carry the necessary weight and be durable and yet soft enough to readily conform to the wearing of the journal. Because of the longer life of such a bearing and the practical elimination of hot boxes, the expense of maintaining it will be greatly reduced. At the present time several roads have ordered trial bearings and are testing them out. Fig. 6 shows the bronze crown of a car journal bearing before the babbitt is applied.

AUTOMATIC BELT TIGHTENING IDLER.

An automatic belt tightening attachment for the standard Crocker-Wheeler form L motor, having a rear end shield, is shown in the accompanying illustration, and may be used wherever the limited center distances between pulleys require an increased belt contact on the pulley surface. Its principal parts are the idler pulley, an arm and block, a spring stud and block and an adjustable spring and hook connecting them.

The idler pulley and arm are pivoted on a stud, which may be screwed into either one of two tapped holes in the block. The block itself may be attached to the motor in any one of four positions by a special screw replacing any one

Automatic Belt Tightening Idler.

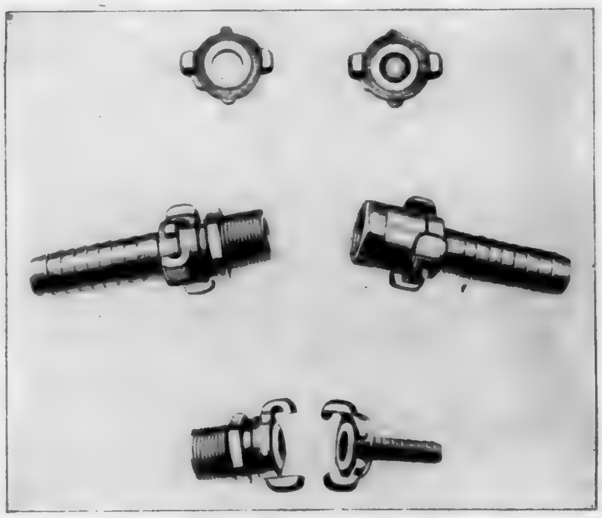
of the four machine screws holding the rear shield to the motor frame. Eight locations are thus afforded for the pivot of the idler arm. The stud to which the spring is anchored may in like manner be screwed into either one of two holes in a block similar to the one just described, and this block may be mounted in any one of the three remaining positions on the rear shield. The position which should be used will depend upon the way the idler pulley rests on the belt. When these parts are put in position, further adjustment may be obtained by screwing the hook in and out of the spring before hooking them on to the attachment. Adjustment for stretch of the belt may also be readily made in this manner at any time.

Cement for Iron Pipe Leaks.—A cement for closing leaks in iron pipe consists of coarsely powdered iron borings, 5 lbs.; powdered sal ammoniac, 2 ozs.; sulphur, 1 oz., and water sufficient to moisten it. This composition hardens rapidly; but if time can be allowed it sets more firmly without the sulphur. It must be used as soon as mixed.—*The Mechanical Engineer.*

Make Cabs Convenient.—A train running at the rate of 60 miles per hour, which is a very ordinary rate of speed for passenger trains of the present time, would travel at the rate of 88 ft. per second; while the engineer turns around for the short space of five seconds to apply an injector his train would have run exactly one-twelfth of a mile, and five seconds is not an excessive amount of time to be used in applying an ordinary injector. This does not apply to the injector alone, but to all of the valves in the cab that have to be operated while the locomotive is in motion. They should all be placed within easy reach of either the engineer or fireman, to avoid the necessity of having to turn around to operate them.—*Traveling Engineers' Association.*

A NEW HOSE COUPLER

The Chicago hose coupler, illustrated herewith, was designed to meet the demand for a standard hose coupler to avoid extra expense for specially constructed couplers to suit the various sizes of hose used with pneumatic tools. Referring to the illustration, it will be seen that it has no male or female parts at the coupling end, but that each half has both male and female features, so that each half is exactly the same and will couple regardless of style and size of shank, making it in every sense of the word a universal coupler.



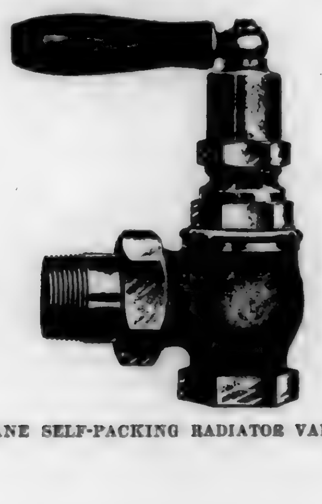
THE CHICAGO HOSE COUPLER.

With these couplers ¼-in. hose may be coupled with ¾-in. hose, or to anything having one of these couplers attached to it.

The shanks are manufactured for pipe male thread, pipe female thread and hose in standard commercial sizes ¼ in. up to 1 in., which enables all couplings to be made without resorting to reducers or special shanks to meet the conditions presenting themselves where pneumatic tools are in use. They are manufactured by the Chicago Pneumatic Tool Company, who have arranged to carry a large stock constantly on hand, their manufacturing facilities being equal to 500 sets per day.

QUICK OPENING, SELF-PACKING STEAM RADIATOR VALVE

The Crane Company, of Chicago, are placing on the market a new self-packing, quick-opening, steam radiator valve, the self-packing feature eliminating any possibility of the valves leaking at the stuffing box. By means of a special device placed in the stuffing box the packing is automatically kept tight, and will last for years without renewal. The device is very simple, consisting of a vulcanized washer placed in the top of the stuffing box and kept in position by spring compression, which fully compensates for the wear on the washer. The valves open and close by turning the lever handle one-half turn, and this lever handle may be operated by foot as well as by hand. The construction of the valve is such that when closed the discs bear on the seat very tightly and the valve is locked in place until released. The bonnets of these valves are interchangeable with those of the regular Crane radiator valves, and the user may thus at any time equip his old valves with these new improvements.



CRANE SELF-PACKING RADIATOR VALVE.

BOOKS.

The World's Locomotives. By Charles S. Lake. 380 pages. Published by Spon & Chamberlain, 123 Liberty Street, New York. 1905. Price, $4.00.

This is a valuable digest of the latest locomotive practice throughout the world. The most recent types of locomotives are illustrated, and their most important features are considered. The first half of the book is devoted to British locomotives. About 50 pages of the second half are devoted to locomotives in this country. The book contains over 300 illustrations and 8 large plates.

Railway Storekeepers Association. Proceedings of the second annual meeting held at Chicago, May 22-23, 1905.

The large attendance at the meeting (73 members representing 36 roads), the many new members added, the lively and thorough manner in which the various subjects were discussed and the valuable information brought out, indicates that this associaiton is in a most flourishing condition. Motive power officials should carefully read the discussions. Mr. J. P. Murphy, general storekeeper of the Lake Shore & Michigan Southern Railway, Collinwood, Ohio, was re-elected president of the association.

American Railway Master Mechanics Association. Proceedings of the thirty-eighth annual convention, held at Manhattan Beach, N. Y., June, 1905. Edited by the secretary, Mr. J. W. Taylor, Old Colony Building, Chicago, Ill.

In addition to the committee reports, topical discussions and the association rules and standards, are two specially valuable individual papers, one on "The Use of Superheated Steam on Locomotives," by Mr. H. H. Vaughan, and the other on "The Technical Education of Railroad Employes," by Mr. G. M. Basford. As usual, the secretary is to be complimented upon the short time required to get out this report, which covers 411 pages in addition to the plates showing details of the association standards.

Train Resistance and Power of Locomotives. Published by the American Locomotive Company, 111 Broadway, New York.

This publication contains a number of valuable tables and data, showing the tractive power of locomotives per pound of mean effective pressure, the tractive power of locomotives at slow speeds for boiler pressures of 180, 190, 200, 210 and 220 lbs.; piston speeds in feet per minute at 10 miles per hour and the number of revolutions per mile for different wheel diameters; speed factors for calculating tractive power; train resistance for various speeds and grades, horse power for various speeds and grades; speed: seconds per mile in miles per hour; cylinder volumes; heating surface of tubes; weight of tubes; curve ordinates; metric conversion tables, and classification of locomotives. Copies of this publication will be furnished on application to the American Locomotive Company.

Government Regulation of Railway Rates. By Hugo Richard Meyer, assistant professor of political economy in the University of Chicago. 486 pages. Published by MacMillan Company, New York, 1905. Price, $1.50.

The author has made a careful study, extending over twelve years, of the railway question in the United States, Germany, France, Austria, Hungary, Russia and Australia. After reviewing at length the effect of government regulation of railways in foreign countries and studying the development of railways in this country, his conclusion is that "It is impossible for the State to conserve and promote the public welfare by intervening in the regulation of railway rates beyond the point of seeking to abolish secret personal discriminations, guaranteeing that all rates shall be reasonable *per se* and providing that those rates which involve the question of relative reasonableness shall embody compromises which were made with intelligence and in good faith."

Mr. W. G. Rose has been appointed general foreman of the Wabash at Saint Louis, Mo.

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PERSONALS.

Mr. G. W. Taylor has been appointed master mechanic of the Atchison, Topeka & Santa Fe at Arkansas City, Kan.

Mr. W. G. Edmondson has been appointed engineer of tests of the Philadelphia & Reading, with headquarters at Reading, Pa.

Mr. P. J. Harrigan, general foreman of the Baltimore & Ohio at Connellsville, Pa., has been appointed master mechanic at that point.

Mr. F. H. Riley has been appointed general foreman of the roundhouse and repair shops of the Chicago & Eastern Illinois at Terre Haute, Ind.

Mr. John Cullinan has been appointed master mechanic of the Central Indiana, with headquarters at Muncie, Ind., succeeding Mr. S. W. Crawford.

Mr. A. McCormick has been appointed master mechanic of the Valley and Arkansas divisions of the Missouri Pacific at Little Rock, Ark.

Mr. W. A. Mitchell has been appointed master car builder of the Missouri, Kansas & Texas, with office at Sedalia, Mo., succeeding Mr. H. A. Bowen.

Mr. John G. Smith has been appointed master mechanic of the Coahuila & Pacific division of the Mexican Central Railway, with office at Saltillo, Coah.

Mr. H. K. Mudd, general foreman of the Wabash at Saint Louis, Mo., has been appointed division master mechanic of the Missouri Pacific at Little Rock, Ark.

Mr. W. J. Schlacks has been appointed superintendent of machinery of the Colorado Midland, with office at Colorado City, Colo., succeeding Mr. J. R. Groves.

Mr. C. J. Bushmeyer has been appointed acting master mechanic of the Denver, Enid & Gulf, with headquarters at Enid, Okla., to succeed Mr. W. E. McEldowney, resigned.

Mr. J. E. Brooks has been appointed acting general foreman of the St. Louis & San Francisco at Monett, Mo., and Mr. George E. Oliver, general foreman at Fort Scott, Kan.

Mr. C. Paskeron has been appointed general foreman of the Eastern Division of the El Paso Southwestern System at Alamogordo, N. M., in place of Mr. T. Fielden, resigned.

Mr. C. L. Bundy, general car foreman of the Colorado & Southern, has been appointed general foreman of the Kaiser Valley shops of the Delaware, Lackawanna & Western at Scranton, Pa.

Mr. A. W. Nelson has been appointed division foreman of the St. Louis & San Francisco at Beaumont Junction, Kan., in place of Mr. William Gibson, who has been transferred to Cape Girardeau, Mo.

Mr. James Ogilvie, heretofore superintendent of motive power of the Canada Atlantic, has been appointed master mechanic of the Ottawa division of the Grand Trunk, with headquarters at Ottawa, Ont.

Mr. C. B. Sumers has been appointed road foreman of engines of the St. Louis division of the Toledo, St. Louis & Western. Mr. M. Marea has been appointed road foreman of engines of the Toledo division.

Mr. S. M. Dolan, division master mechanic of the Missouri Pacific at Baring Cross, Ark., has been transferred to the new shops at Sedalia, Mo. Mr. B. E. Stevens has been appointed to succeed Mr. Dolan as division master mechanic at the Baring Cross shops.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

VALVE CHARTS.—The Locomotive Appliance Company, Chicago, Ill., in their catalog No. 9 present a number of diagrams, charts and valve motion reports which concern the advantages of the Allfree-Hubbell locomotive.

HEATING APPARATUS.—Catalog No. 136, from the American Blower Company, Detroit, Mich., is devoted to their "A. B. C." heating apparatus, which is adapted for heating and ventilating factories and public buildings and for the drying of materials of all kinds.

NORTHERN FORGE BLOWERS.—The Northern Electrical Manufacturing Company, Madison, Wis., have issued a small leaflet, No. 145, which describes their electric blowers for operating forges. These blowers are made in several different sizes, and are compact and self-contained.

ROTARY CONVERTERS.—Special publication No. 7038, from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to Westinghouse rotary converters, and considers their characteristics and construction, with very complete instructions for their erection, operation and care.

METALLIC PACKINGS.—The United States Metallic Packing Company, Philadelphia, Pa., have issued a catalog describing their metallic packings for locomotive piston rods and valve stems; it also contains some items concerning their care and maintenance and a description of the Gollmar bell ringer.

AIR-COOLED ELECTRIC DRILLS.—Special circular No. 52, from the Chicago Pneumatic Tool Company, Chicago, describes their air-cooled Duntley electric portable drills, and also contains the results of several interesting tests which were recently made with different sizes of these drills, in which ordinary twist drills from ⅝ to 2 15-64 ins. in diameter were worked to the limit of their capacity.

MULTIPLE VOLTAGE.—The Allis-Chalmers Company have just issued bulletin No. 1044, which considers the Bullock multiple voltage system of control for variable speed motors. This system may be used with either three or four wires, and the advantages of the two arrangements are briefly considered. In addition, considerable space is devoted to a comparison of the different variable speed systems. Bulletins Nos. 1040 and 1045 are devoted to the Bullock polyphase induction motors and their construction, and to Bullock rotary convertors.

GISHOLT LATHES.—This is the title of a handsome and very completely illustrated catalog received from the Gisholt Machine Company, which describes the various types of their well-known turret lathes, and illustrates a number of typical parts used in connection with various classes of machinery which may be manufactured on these lathes to considerable advantage. Their boring mills and universal tool grinders are also briefly described. This is a separate catalog and is not intended to be bound with the loose leaf bulletins which they issue from time to time.

ELECTRICAL APPARATUS.—Special publication No. 7040, from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to Westinghouse railway apparatus, and considers their direct current and single phase alternating current motors, generators, railway controlling appliances and the Baldwin-Westinghouse electric locomotives. Circular No. 1120 is devoted to their railway motor No. 113 for direct current service, this being the largest capacity motor which has been used for passenger service. Circular No. 1123 considers the Westinghouse prepayment wattmeters.

A MARKED ADVANCE IN LOCOMOTIVE BOILER MAINTENANCE.—A handsome publication with this title has just been sent out by the Kennicott Water Softener Company, Railway Exchange Building, Chicago. It contains a reprint of a paper read before the Western Railway Club by Mr. A. R. Raymer, Assistant Chief Engineer of the Pittsburg & Lake Erie Railroad, in which he described the Raymer boiler water changing device, so successfully used on that road, and told of the advantages which were being gained by its use. The Kennicott Company announce that they have secured exclusive manufacturing and selling rights under the patents granted to Mr. Raymer covering apparatus and methods employed in the construction of this device.

AUTOMATIC BELT TIGHTENING IDLER.—Flyer No. 276, from the Crocker-Wheeler Company, Ampere, N. J., describes a newly-designed automatic belt tightening attachment for their standard form L motor, which may be used wherever the limited distances between pulleys requires an increased belt contact on the pulley surfaces.

JEFFREY ELECTRIC MINE LOCOMOTIVES.—Bulletin No. 10, from the Jeffrey Manufacturing Company, Columbus, Ohio, is devoted to the Jeffrey electric locomotives for mines, which include the ordinary type operating with the overhead trolley system, the Jeffrey gathering locomotives, rack rail locomotives and storage battery locomotives. The bulletin is handsomely illustrated, showing both general views of the large line of locomotives and also the details of some of the more important features.

ELECTRIC CARS.—The most handsome catalog ever issued by a car company has just been received from the J. G. Brill Company, Philadelphia, and presents a valuable record of the most modern types of city and interurban electric cars and trucks. It is 10 by 14 ins., is bound in cloth and contains 90 pages. Forty-five standard cars, representing the foremost types in the various forms of city and interurban service, are illustrated and described, and, in many cases, the most important features are illustrated in detail. Considerable space is also devoted to the general and detail construction of the various well-known Brill trucks. The last few pages are devoted to a number of patent car specialties which this company is prepared to furnish, in addition to repair and supply parts of all kinds.

MILLING MACHINES AND CUTTER GRINDERS.—The Cincinnati Milling Machine Company, Cincinnati, Ohio, are sending out a new 109-page catalog of standard 6 x 9 size. This is one of the most complete treatises on milling machines that has come to our notice, and in addition to a very completely illustrated description of the important details of the Cincinnati millers, contains photographs and specifications of their various machines, and also devotes considerable space to the application of electric motors and to the attachments which they are prepared to furnish for use with their millers. It also contains several speed tables for high speed steel cutters, and as these have been very carefully developed should prove of special value to those who are using these cutters.

GOLD CAR HEATING & LIGHTING COMPANY.—We have just received from the Gold Car Heating and Lighting Company, New York, a handsome catalog, 9 by 12, cloth bound, containing 128 pages. A careful study shows that a number of improvements have been made, both in their steam heating apparatus and the electric heaters. One of the most important improvements is an improved temperature regulator, which affords perfect control of the temperature. This device is very simple, compact, durable and inexpensive and may be applied to any modern heating apparatus. It has been thoroughly tested during the past winter with very gratifying results. A list of 256 railways which use the Gold devices is presented and copies of a few of the many letters of approbation which have been received are reproduced. Nearly 40,000 cars and locomotives are equipped with the Gold heating apparatus. The catalog is very complete and should be in the hands of all those who are interested in car heating, as it forms a valuable contribution to the literature on this subject.

NOTES.

AMERICAN WATER SOFTENER CO.—This company of Philadelphia, report orders for water softening and purifying plants from the Florida East Coast Ry., and the Detroit, Toledo & Ironton Ry.

AMERICAN BLOWER COMPANY.—This company of Detroit, Mich., reports that among other large orders they have received one for the complete heating apparatus for the new Allegheny shops of the Pennsylvania Lines West.

GENERAL ELECTRIC COMPANY AWARDS AT PORTLAND EXPOSITION.—This company announces that they have received a gold medal for the best exhibit in the electrical department, and, in addition to this, they have been awarded 10 other gold medals for various features of their exhibit.

KENNICOTT WATER SOFTENER COMPANY.—This company, of Chicago, announces that they have recently received an order and are at present constructing 18 steel 65,000-gallon storage tanks of the Harriman pattern, for the Union Pacific Railroad.

SAFETY CAR HEATING & LIGHTING COMPANY.—This company, of 160 Broadway, New York, announces that Mr. B. V. H. Johnson, general agent of the company at St. Louis, has been transferred to Philadelphia to take the place of Mr. F. S. Bristow, deceased, and that Mr. Charles B. Adams has been appointed to succeed Mr. Johnson.

FALLS HOLLOW STAYBOLT COMPANY.—This company of Cuyahoga Falls, Ohio, announces that they have secured Mr. F. C. Lippert, 5654a Bartmer avenue, St. Louis, as traveling representative for western territory. They also announce the receipt of large orders for shipment to the American Railroad Company, San Juan, Porto Rico, and to Japan.

O. M. EDWARDS COMPANY.—This company, of Syracuse, N. Y., announces that Mr. W. G. Willcoxson, of 20 Forty-second Place, Chicago, has been appointed to represent them in Chicago. Also, that Mr. E. F. Chaffee, formerly passenger car foreman of the New York Central at the West Albany shops, has been appointed to represent them in the East and will be located at New York.

WM. B. SCAIFE & SONS COMPANY.—This company of Pittsburg, Pa., announces that they have contracts for a larry trestle of steel construction for the Colonial Coke Company in Fayette County, Pa., and also for the structural steel and plate work of a new blast furnace for the Dunbar Furnace Company, Dunbar, Pa. The Washington Coal & Coke Company have contracted with them for the structural steel for a large power plant at Star Junction, Pa.

PRATT & WHITNEY COMPANY.—It is announced that this company has purchased a plant in Dundas, Ontario, for the manufacture of their full line of small tools—taps, reamers, milling cutters, punches, dies, etc. The building is a modern structure and the power plant is already in place. The machinery equipment is being gotten ready at Hartford, and will be sent there and operations begun immediately. The plant will also include a department for manufacturing a full line of twist drills, an elaborate equipment of special machinery having been gotten ready for the purpose. The location of the factory is near that of the John Bertram & Sons Company, which, as has been announced, was recently purchased by the Niles-Bement-Pond Company.

NORTHERN ELECTRICAL MANUFACTURING COMPANY.—The manufacturers who plan the application of the motor drive to machines and machine tools are often unable to make satisfactory progress with the work because of the lack of information necessary to enable the electrical manufacturer to bid on suitable machines. For the electrical manufacturer usually follows a request for quotations with a request for complete and detailed information regarding the motor equipment needed. The Northern Electrical Manufacturing Company, Madison, Wis., is able to send the purchaser quotations on Northern motors for application to machines and machine-tool drives upon learning of the class of work to be accomplished and the voltage of the power circuit from which the current is to be taken. It has had extensive experience in applying motor drives in all kinds of manufacturing plants for increased output and is usually able to determine upon the proper sort of motor equipment to be applied upon learning of the conditions.

MORSE CHAIN COMPANY.—The rapidly increasing business of this company has necessitated the building of a large new plant at Ithaca, N. Y., which will be operated in conjunction with the present factory, situated at Trumansburg, N. Y. The main building, which will contain the general offices, will be 64 x 303 ft. and three stories in height. The first floor will be used for the machine shop. The other buildings to be provided will be one story in height and their general dimensions are as follows: Foundry, 68 x 135 ft.; forge shop, 36 x 80 ft.; pattern shop, 82 x 28 ft.; powerhouse, 105 x 45 ft. Steel and concrete construction has been used throughout and everything has been done to provide for an equipment in keeping with advanced machine shop practice. Gear cutters, boring mills, lathes and general plant equipment to the amount of $50,000 will be installed, a greater portion of which has already been purchased. The machine shop will be equipped with 10-ton electric traveling cranes. The foundry will be equipped with electric cranes of 15 tons capacity, having a span of 50 ft.

(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

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POWER HOUSE.

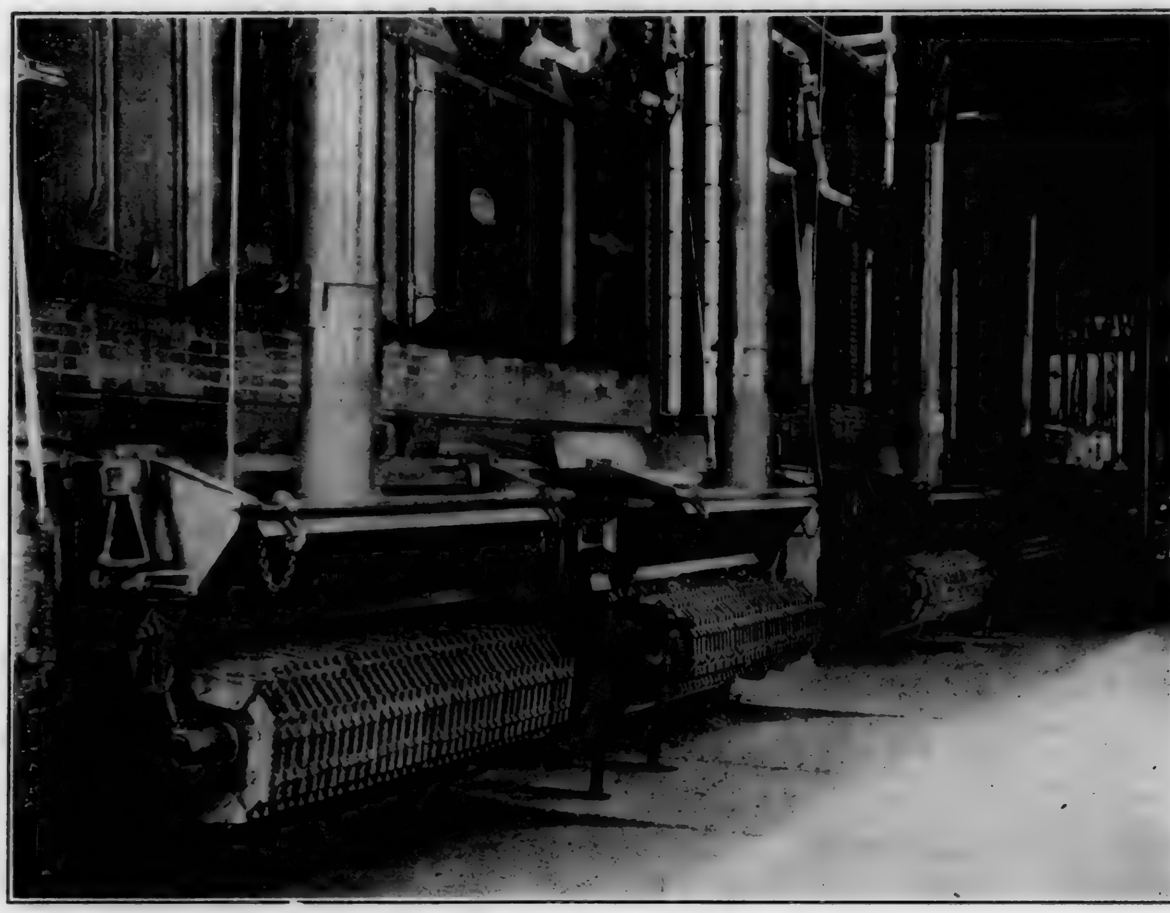
The power house is located centrally with regard to the locomotive and car departments, and is equipped to furnish power for both of them, although it will probably be some time before the car department is installed. Careful provision has been made to avoid the necessity of a shutdown, due to the failure of any of the machines or equipment. The building is large enough to accommodate a considerable increase of equipment and, if necessary, can be extended to the north. Due to the use of a conveyor for coal and ashes and to the Green chain grates, the boiler room presents a very clean and neat appearance. Mechanical draft is used in place of the usual high chimney, and the induced draft plant used in connection with an economizer is not only very efficient, but is less expensive than the ordinary arrangement where a high chimney is used. Although a low grade of Illinois coal is burned, the stokers and draft may be so nicely regulated that no smoke escapes from the chimney. As the exhaust steam is used for heating the shops, the engines are run non-condensing. Direct current at 230 volts is provided for the cranes, heating fans and constant speed machine tool motors. For the variable speed machine tool motors and the lighting, current at 230 volts and 115 volts is furnished by a three-wire system, the two voltages being obtained by a Bullock balancer set. As the pumping station is located almost two miles from the power house, the first cost of wire for transmitting the direct current would be excessive, and an inverted rotary converter and a static oil-cooled transformer in the power house transform the direct current into alternating current at 2,300 volts. The plant is to be commended for its completeness, its economical operation, the guards which are provided to prevent the necessity of a shutdown due to accidents, and the provision for future extensions.

Building.—The power house has concrete foundations, brick walls and a gravel roof supported on steel trusses. The roof construction is the same as used on the other buildings, and is described on page 392. The basement is 9 ft. high, and in addition to the stairway leading to the engine room has an outside stairway of concrete. The main floor is of concrete supported by cast iron columns and steel beams. The power house lies about 60 ft. to the north and 95 ft. to the east of the store house. It is 154 ft. 2 ins. by 104 ft. 7 ins., and is divided longitudinally by a brick wall into a boiler room and an engine room, each 49 ft. 10 ins. wide. On the west is an addition 45 ft. by 27 ft. 6 ins., containing the induced draft apparatus, and on the south is an addition 18 ft. by 33 ft., through which the coal supply track runs; below this track is the coal hopper, and above is the ash hopper used in connection with the coal and ash conveyor. The height from the floor to the roof truss in the engine room is 30 ft. The engine room is equipped with a 10-ton overhead traveling crane which is operated by hand. The interior finish of the boiler room is a dark-red pressed brick. The engine room is finished in buff-colored pressed brick, with a wainscoting of white enamel tile 7 ft. high, with a baseboard and coping of dark green. The machinery is painted dark green, and the engine room thus presents a very neat and handsome appearance.

Boilers and Stokers.—Six 300-h.p. Babcock & Wilcox vertical header type boilers are set in three batteries of two each with their backs 10 ft. from the dividing wall. The furnaces are 8 ft. in height, measured from the floor line to the bottom of the header. This extra height is specially valuable in providing a large combustion chamber for highly volatile fuels. The boilers carry 150 lbs. of steam, and are equipped with Green chain grates. Two additional boilers are to be added, as indicated by the dotted lines in the drawing, and, if necessary, a boiler may be added at each end of the row. The piping is so arranged that these additions may be made without interruption to the service. The breeching is lined with firebrick, and is carried on columns along the dividing wall, leaving a pasageway underneath it, and sufficient room between it and the boilers for a man to work around or to enter the manholes in the back of the drums. The passageway to the engine room leads between the boilers at the center of the room. The Green chain grate stokers are driven by two 6-h.p. engines located in the basement.

Economizer.—Directly above the passageway to the engine room is the economizer chamber, which is supported on cast iron columns. This chamber is divided by a brick partition into two unequal flues, the larger of which contains a Green economizer. The other is used as a by-pass when the economizer is being cleaned or repaired. The economizer consists of 60 sections of 10 tubes, arranged in groups of 20 sections each, making a total of 600 tubes, with a heating surface of 7,200 sq. ft. The tubes are of cast iron, 9 ft. long, and are cleaned automatically with Green patent beveled scrapers. By means of dampers in the breeching at either side of the entrance to the economizer either battery of boilers may be cut off. Spouts with tight-fitting covers project downward from the economizer chamber, and bags are tied over them to collect the soot, which is swept down when the economizer tubes are cleaned, thus preventing the dirt from getting out into the room. The temperature of the feed water is about

POWER HOUSE, EAST MOLINE SHOPS, ROCK ISLAND SYSTEM.



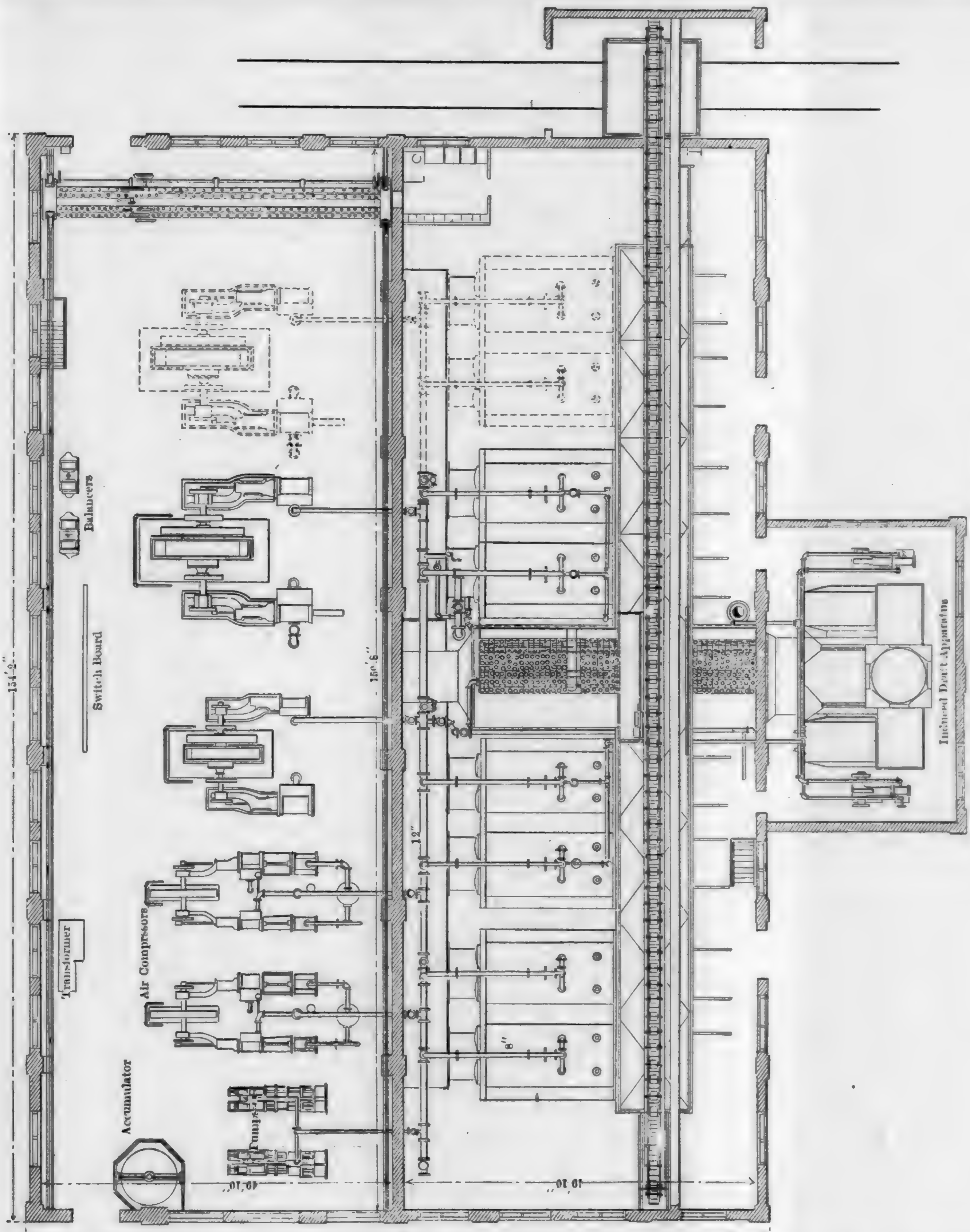
BOILER ROOM, SHOWING CHAIN GRATE STOKERS.

200 deg. as it enters the economizer and 275 deg. as it leaves.

Induced Draft Apparatus.—The induced draft apparatus consists of two exhaust fans, 12 ft. in diameter and 6 ft. wide, driven by 12 by 12-in. longitudinal single cylinder engines built by the Buffalo Forge Company. The speed of the engines is regulated by Foster regulating valves. Either of these fans is of sufficient capacity to handle all the gases from the complete boiler equipment, and dampers are provided to cut off whichever fan is not in use. The stack is of steel, 60 ft. high and 7 ft. 8 ins. inside diameter. The first cost of the steel stack, induced draft apparatus and economizer combined is just about the same as the first cost of a brick chimney for a plant of the same size, and the saving due to the use of the economizer is considerably larger than the cost of operating the induced draft apparatus, so that a net saving results from the use of this system.

Coal and Ash Conveyor.—The arrangement of the coal and ash conveying machinery is clearly shown in the longitudinal cross-sectional view through the boiler room. The coal is delivered directly from hopper cars to a hopper just above the steam-driven coal crusher, and after passing through the crusher is conveyed to overhead storage hoppers by a C. W. Hunt & Company conveyor, which has a capacity of 50 tons of coal per hour. Each boiler has a storage bin of 32 tons' capacity.

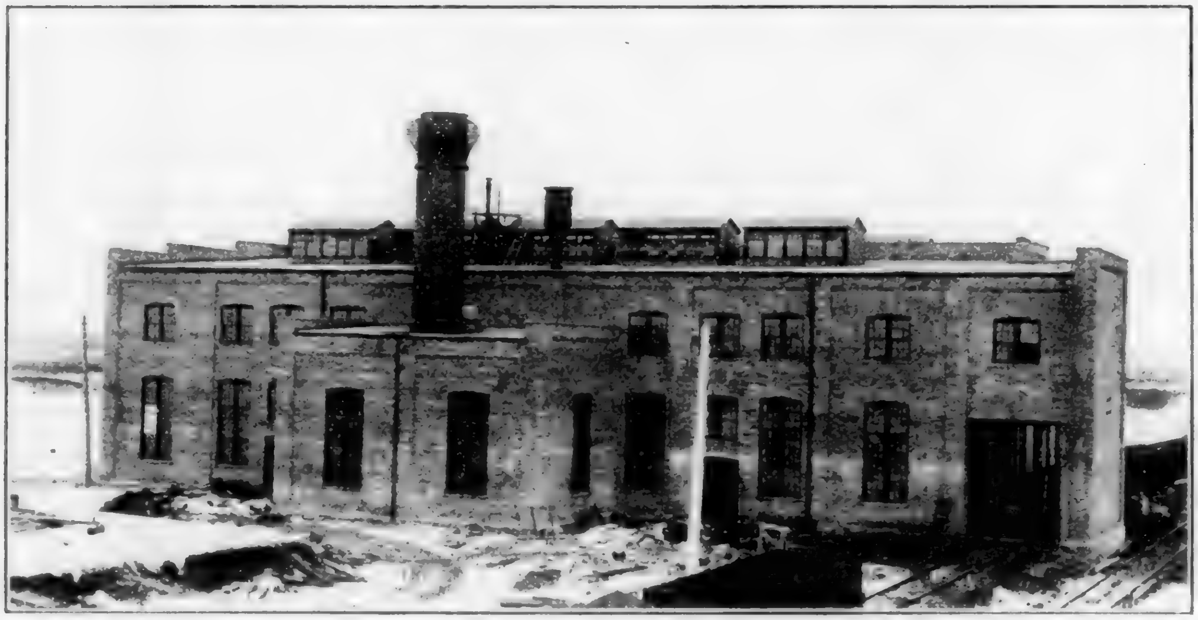
The conveyor also carries the ashes from the ash pits to a



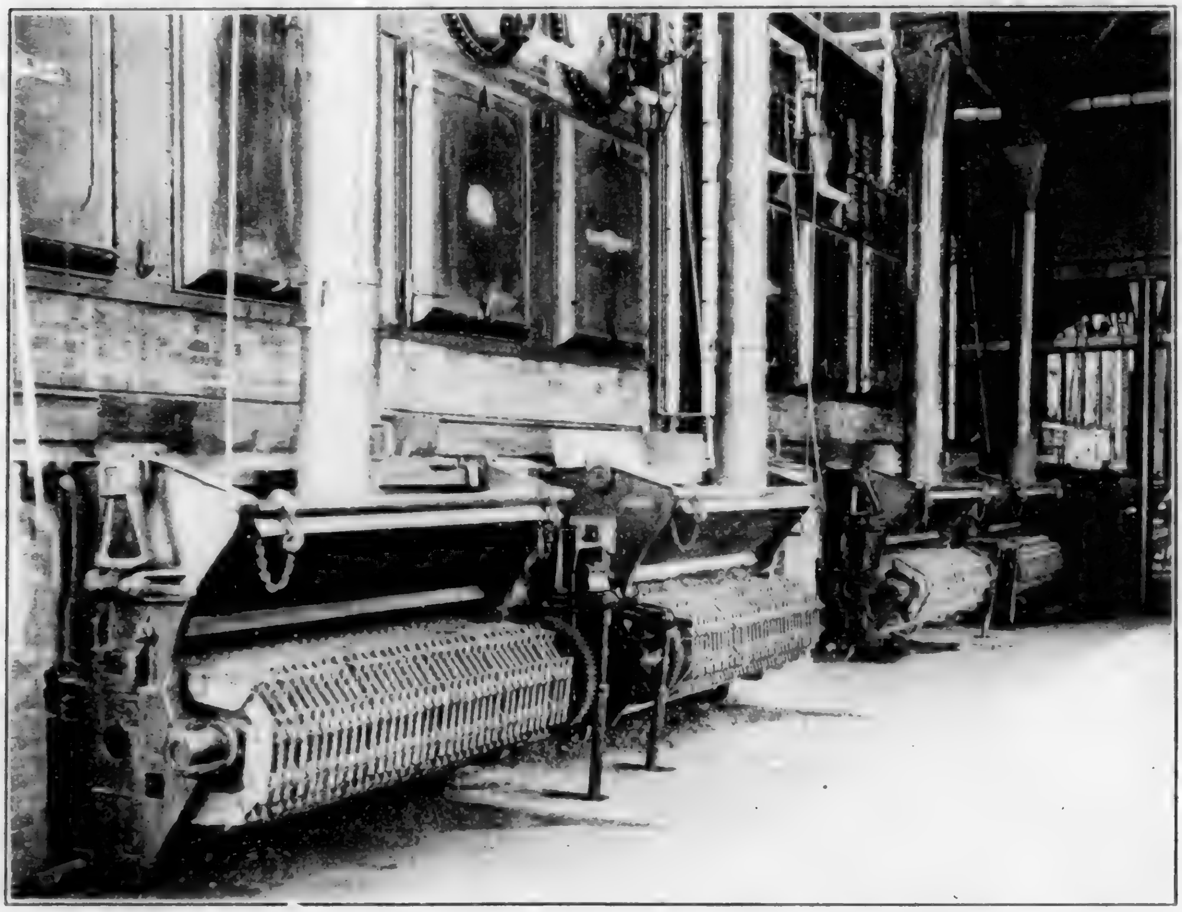
PLAN VIEW OF POWER HOUSE—EAST MOLINE SHOPS.

hopper located in the wing and over the coal hopper, so that the hopper car, when it has been emptied of its load of coal, may be filled with ashes. The engine which drives the conveyor is located above the economizer. Steam is used in preference to electricity as a motive power for the crusher and conveyor, as occasions may arise when it is desired to handle coal or ashes when the generators are not running and also because in case of stalling the motor would be liable to injury while the engine would simply slow down and stop.

Boiler Feed Pumps.—Two Worthington Admiralty boiler feed pumps, 10 and 7 by 10, are installed on either side of the passageway between the boilers. They are arranged to draw from the Webster vacuum heater tank, to which is supplied both fresh feed water and condensed water brought back from the heating system by two Marsh vacuum pumps 10 and 12 by 12. This heater also receives the water from the inter-coolers of the air compressors and from the water-cooled bearings of the induced draft fans. The feed pumps deliver water to the boiler feeding header through the economizer; a by-pass is provided, however, in case the economizer is out of service.



POWER HOUSE, EAST MOLINE SHOPS, ROCK ISLAND SYSTEM.



BOILER ROOM, SHOWING CHAIN GRATE STOKERS.

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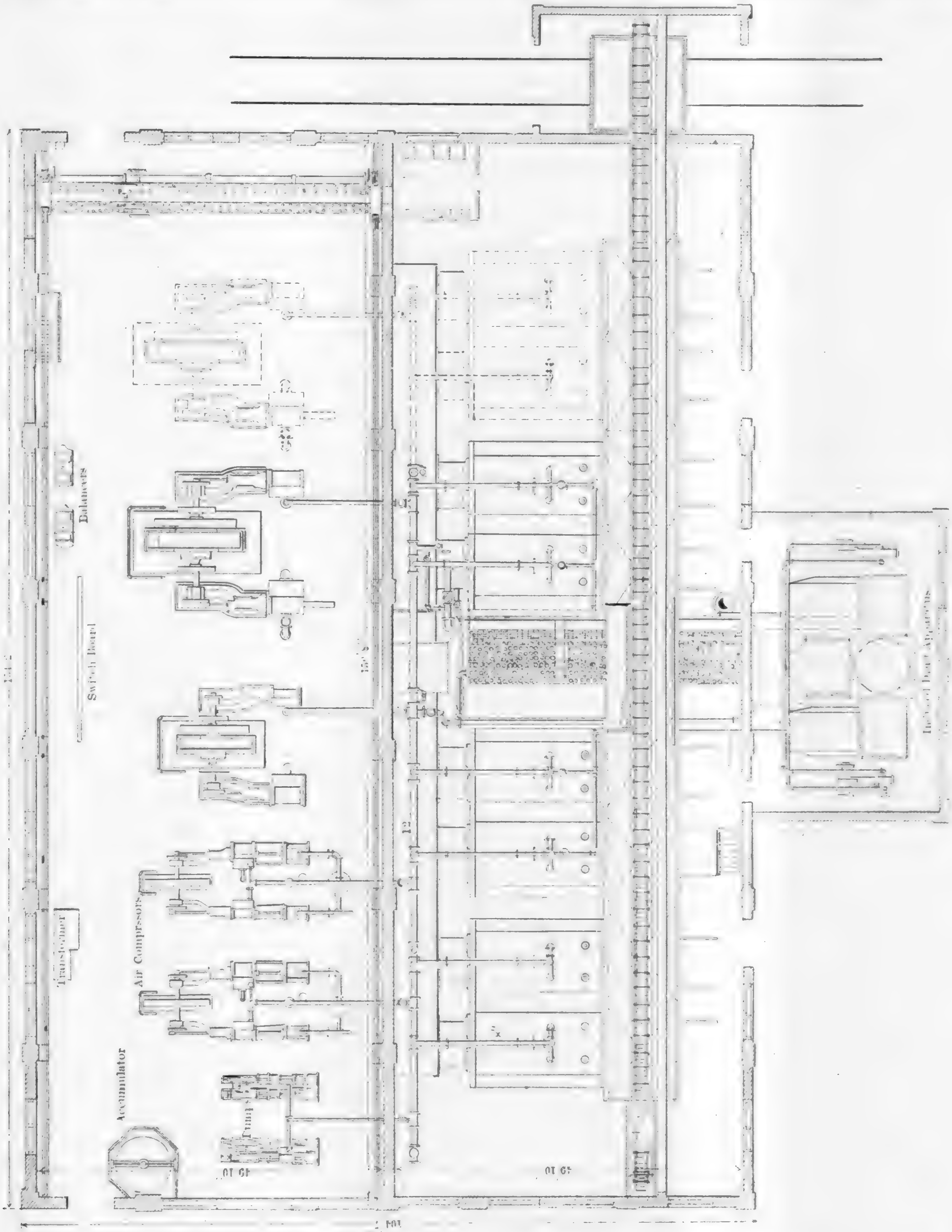

PLAN VIEW OF POWER HOUSE—EAST MOLINE SHOPS.

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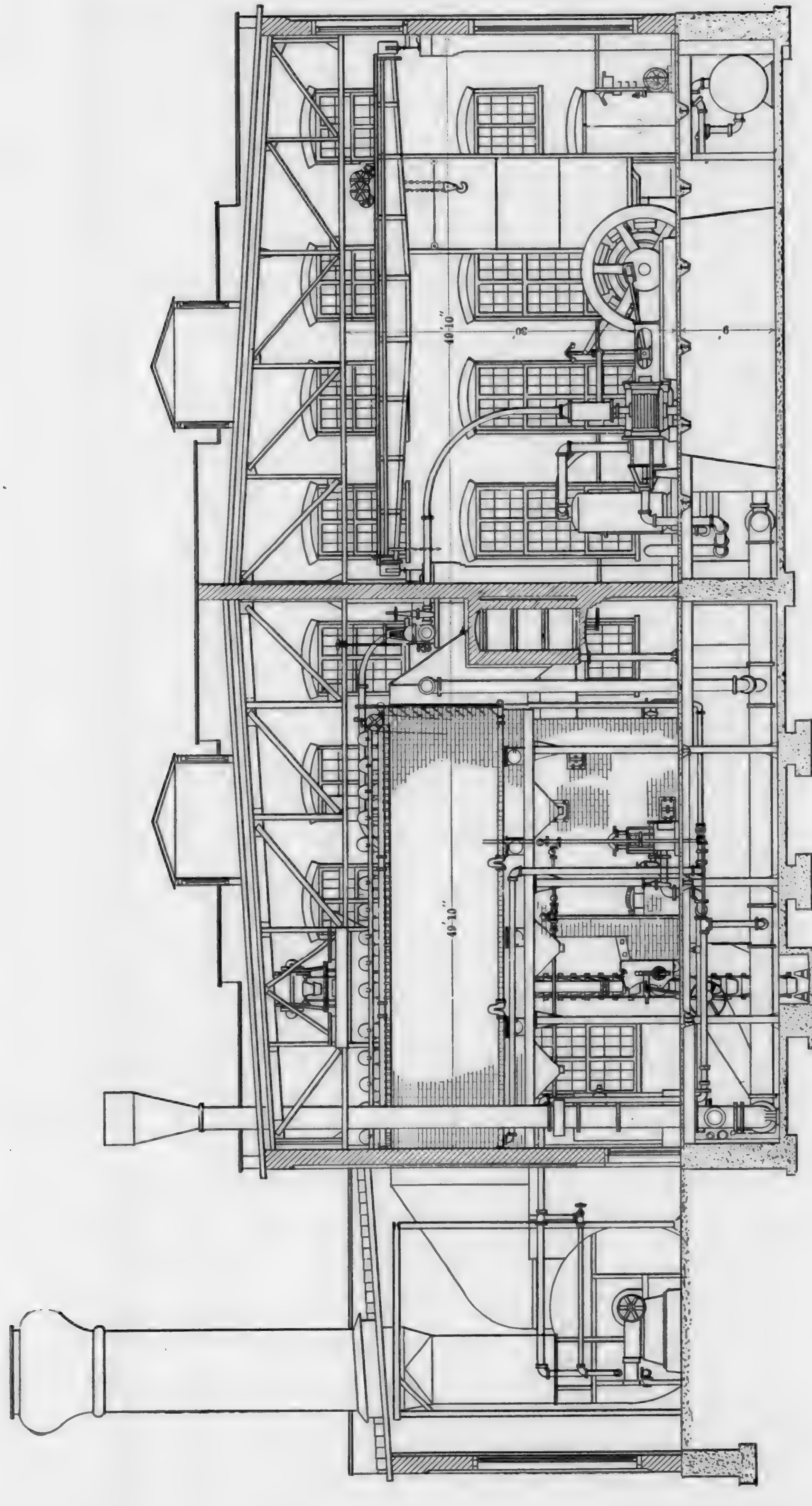
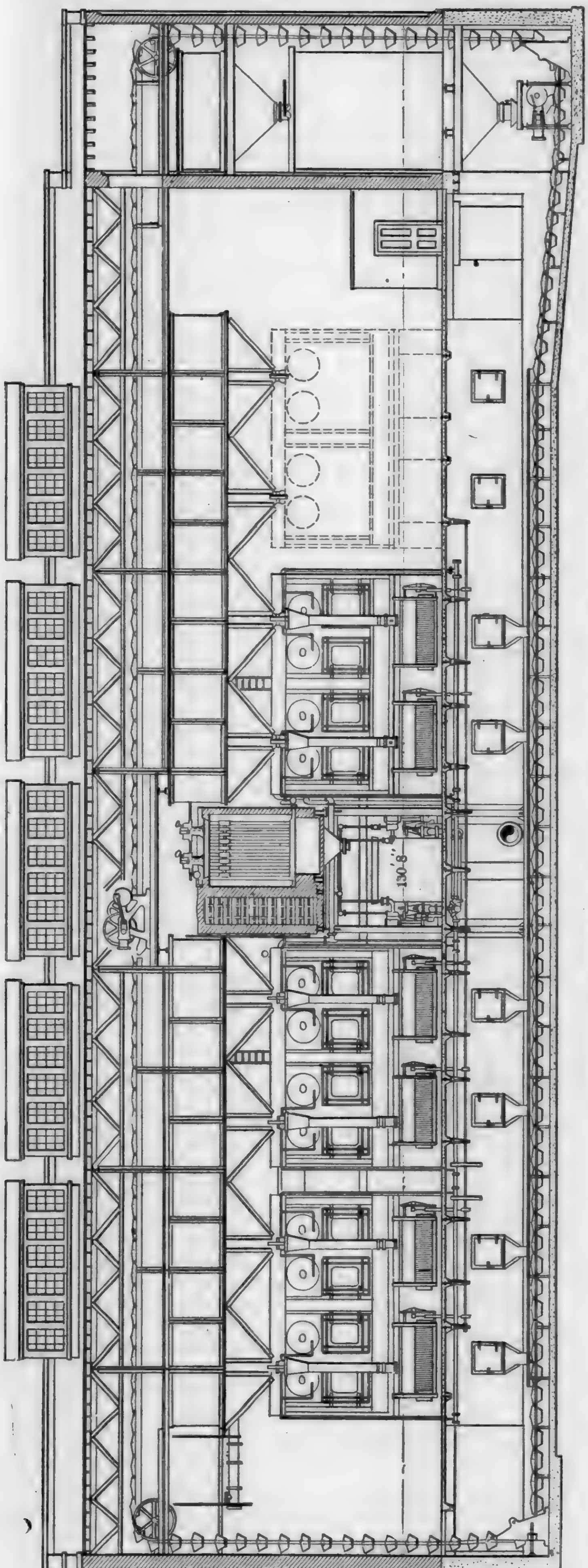


TRANSVERSE CROSS-SECTION THROUGH POWER HOUSE—EAST MOLINE SHOPS—ROCK ISLAND SYSTEM.



LONGITUDINAL CROSS-SECTION THROUGH BOILER ROOM—EAST MOLINE POWER HOUSE.

Piping.—The arrangement of the piping is clearly shown in the cross-sectional views of the power house. The steam pipes from each boiler are 8 ins. in diameter, and have a riser of about 10 ft. and a drop to the header. The header is 12 ins. in diameter, and is supported on a platform which extends along the partition wall on the boiler room side. The steam piping to the engine is 7 ins. in diameter, and has a long sweep of 8 ft. 6 ins. radius. A separator is located directly above the cylinders. The main exhaust pipe is 24 ins. in diameter, is laid along the basement floor, and has a branch to the feed water heater. All high-pressure piping is fitted with the Holly return loop system for handling the condensation.

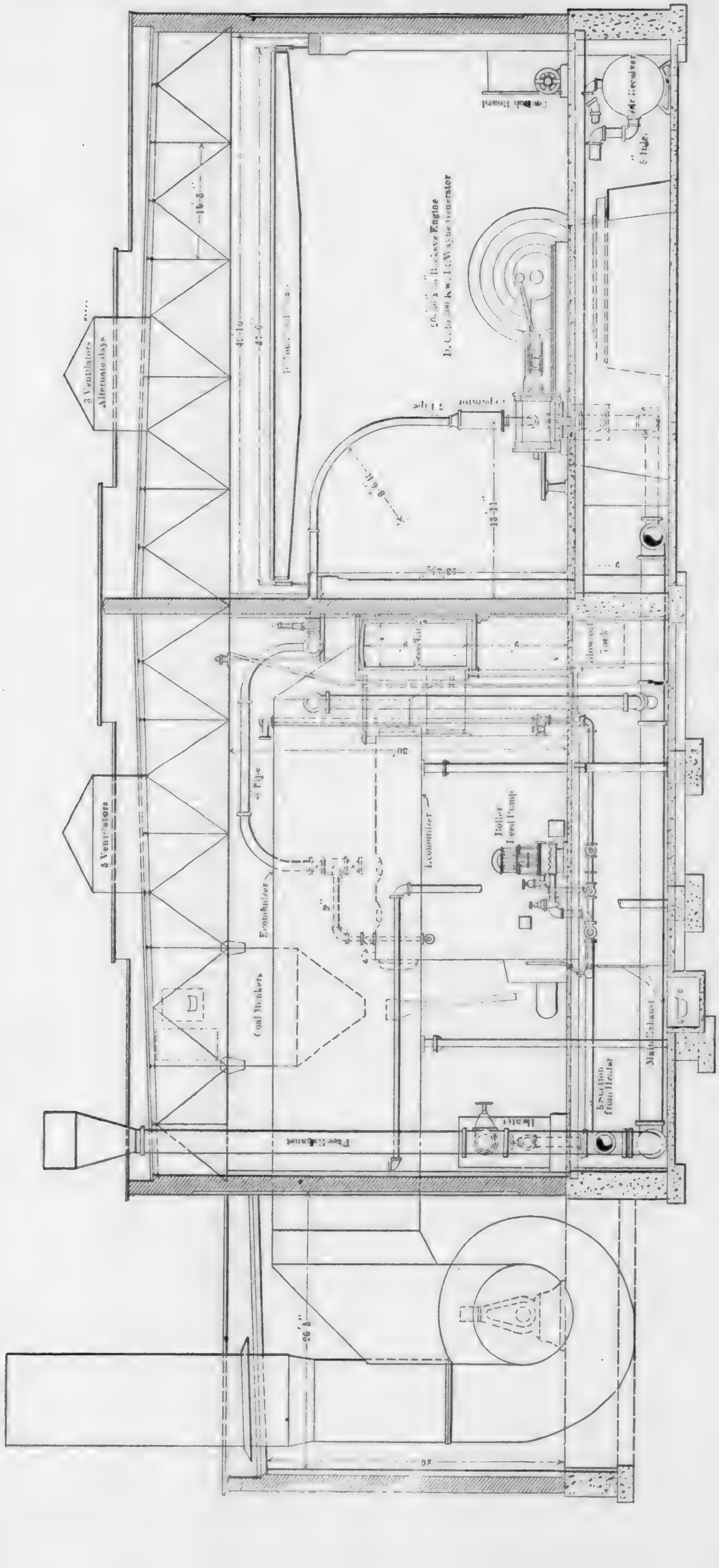
Engines.—The engines are direct connected to the generators, and are Buckeye heavy duty class B cross compounds, and are run non-condensing under 150 lbs. steam pressure. Space for an additional engine and generator is provided as shown by the dotted lines on the floor plan. The larger one is 20 and 36 by 33, and operates at 130 r.p.m. It is rated at 800 h.p., has a 2 per cent. speed regulation from no load to full load, and has a guaranteed steam consumption at economical range of 19 lbs. per horse power hour. The smaller engine is 15¼ and 26½ by 27, and operates at 150 r.p.m. The nominal rating is 400 h.p.; it has a 2 per cent. speed regulation from no load to full load, and a guaranteed steam consumption of 21 lbs. per horse power hour.

Oiling System.—The oiling system is of the J. H. Siegrist automatic type, and is operated by four small Worthington pumps. Two of these pumps supply a line of piping for cylinder lubrication under 165 lbs. pressure, and two supply another line of piping for engine oil under 40 lbs. pressure. In each case one of the pumps is a reserve unit. In case the pump furnishing the cylinder oil should get out of order and the pressure in the line be reduced, it would, of course, be noticed before any damage could be done. In the case of the engine oil, however, considerable damage might result before the stopping of the pump would be noticed, and therefore the gauge for this line of piping is so arranged that when the pressure falls to 10 lbs. an electric contact will be made and an electric alarm bell will ring.

Generators.—The generators were made at the Fort Wayne Electric Works under contract with the General Electric Company, and are of the M. P. L. type, direct current and direct connected. The larger one is a 10 pole, 500 k.w., 130 r.p.m., 250-volt machine, with a vertically split frame. The smaller one is a 10 pole, 250 k.w., 150 r.p.m., 250-volt machine. They are guaranteed to operate at the full rated load continuously with a rise in temperature above the surrounding air not exceeding 35 deg. C. on the armature and field coils and 40 deg. C. on the commutator. With the current increased 50 per cent. at the rated voltage, making a 50 per cent. overload, the generator will operate for two hours with an increase in temperature not exceeding 55 deg. C. in any part of the machine. They will carry a momentary overload of 100 per cent. without injury. Space is provided for an additional 500 k.w. unit.

Balancers.—Two Bullock balancers, one of them a reserve unit, and each of 25 k.w. capacity, furnish the two voltages for the three-wire system.

Air Compressors.—Two class "G. C." Ingersoll-Sargeant air compressors are provided. They are cross compound, steam-driven and non-condensing. The steam cylinders are 18 and 30 ins. in diameter, while the air cylinders are 16½ and 26¼ ins. in diameter, with a 24-in. stroke. The steam pressure is



TRANSVERSE CROSS-SECTION THROUGH POWER HOUSE—EAST MOLINE SHOPS.

150 lbs. and the air pressure 100 lbs. The normal speed of the machines is 90 r.p.m., at which they each have a free air capacity of 1,274 cu. ft. per minute. The intake pipe which delivers the cold air from the outside is 12 ins. in diameter. The compressors discharge into a main air receiver, 66 ins. by 16 ft., located in the basement, and from this receiver an 8-in. air main leads to the shops.

Pumps and Accumulator.—At the north end of the engine room are two compound Worthington duplex steam-driven pumps with 14 and 20-in. steam cylinders, 3½-in. plunger and 15-in. stroke, each having a capacity of 150 gals. of water per minute, delivered at a pressure of 1,500 lbs. per sq. in. The hydraulic accumulator is of the ordinary vertical plunger type, with a ram 12 ins. in diameter.

Pure water is obtained for the hydraulic system and for drinking purposes from a well just east of the power house. It is pumped by a triplex, double-acting Deane 10-h.p. electric pump, located in the basement, and having a capacity of 200 gals. per minute.

Water Supply and Fire Protection.—The water supply is obtained from the Mississippi River. The pumping station is located 9,600 ft. from the power house, 400 ft. from the river and 750 ft. from the end of the intake pipe. It is a neat building of dark-red brick, 20 by 40 ft., with a slate roof. It contains two Deming triplex pumps, each having a capacity of 750 gals. per minute. One of these, which is a reserve unit, is driven by a direct connected 60-h.p. Otto gasoline engine; the other one is driven by a 2,180-volt General Electric 50-h.p., 3-phase, 25-cycle induction motor. The alternating current is secured from an inverted 50-k.w. General Electric rotary converter, which is located at the power house, and delivers the alternating current at 25 cycles to a static oil-cooled transformer, which steps it up to 2,300 volts. The intake water main is 12 ins. in diameter, while the main to the plant is 10 ins. in diameter. The water is delivered to two tanks, each of 100,000 gals. capacity. One is a high-service tank, and is elevated 108 ft. and furnishes water for fire protection and for washing boilers. The low-service tank is elevated 20 ft., and furnishes sufficient pressure to distribute water over the plant. By means of valves, which may be operated from the power house, the low-service tank may be cut out and the high-pressure tank may be connected to the low-pressure mains, thus increasing the pres-

sure. The more important fire hydrants are on the high-pressure line, but a number of fire hydrants are on the low-pressure line, and in case of fire the low-pressure tank is cut out and the high-pressure tank is connected to the low-service line.

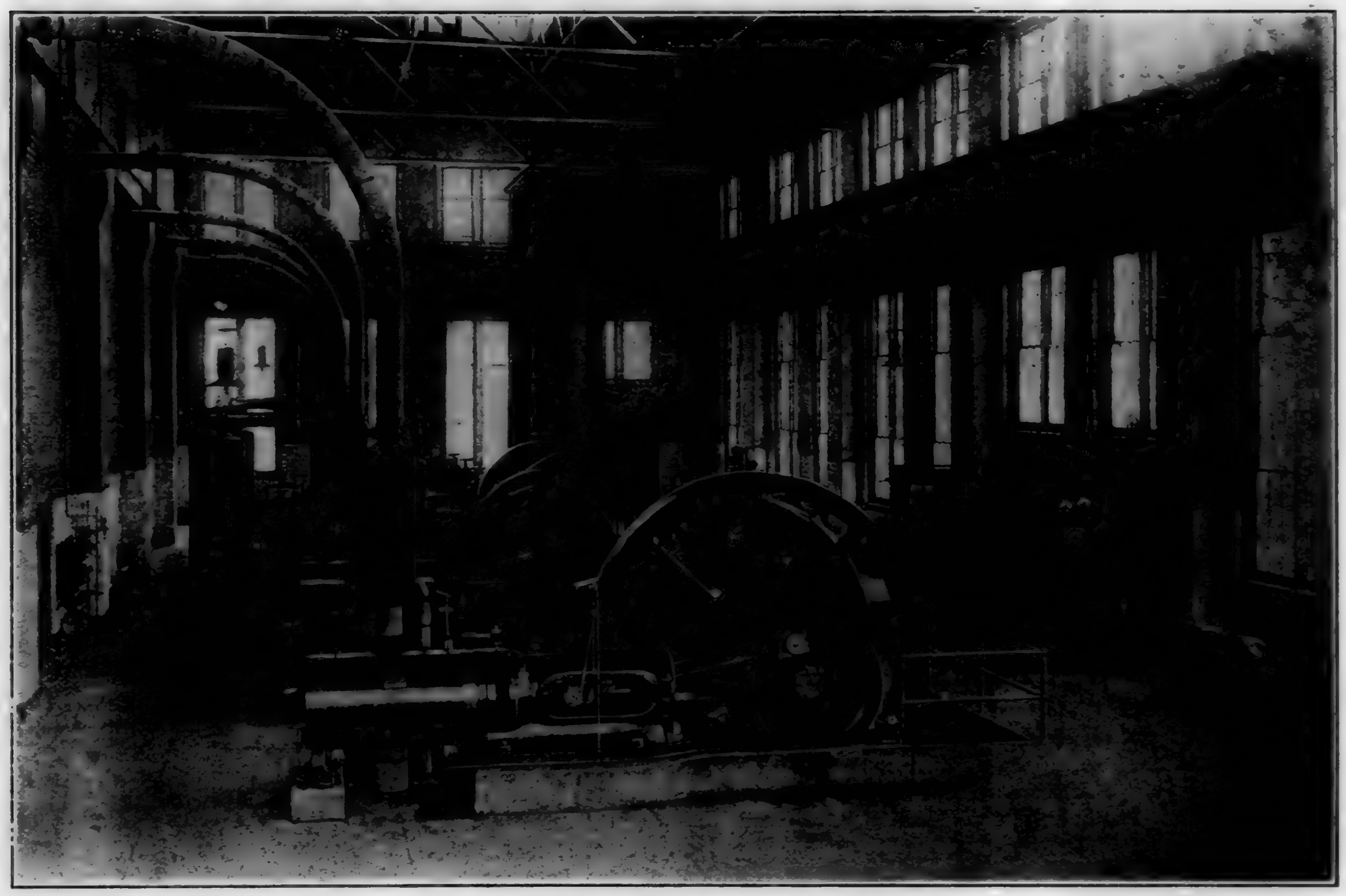
A Fairbank-Morse Underwriters' fire pump, capable of delivering 1,500 gals. per minute or 6⅛ in. streams at 100 lbs. pressure, is located in the southwest corner of the power house basement. Water is obtained direct from supply main from the pumping station with the low-service tank connected as a reservoir on the pump intake. The discharge is connected direct to a 12-in. service main. In addition to this the storehouse is provided with a sprinkler system, which, by an arrangement of check valves, is constantly under pressure from the high-service tank, and is automatically put on fire pressure when underwriters' pump is in operation. In case of fire it is necesary to operate but two valves to put the entire water system under fire pressure. Steam for operating the pump is taken from the south end of main steam header in boiler room, and delivered to pump through a 5-in. direct separator. The pump is controlled by a Fisher governor. The water works system was installed by the Otto Gas Engine Company, Chicago.

Hot Water.—Hot water at 210 deg. Fahr. is supplied from the Webster feed water heater to all the buildings. The outgoing lead is 2½-in. pipe, and from the end of each branch a ¾-in. pipe leads to a 1-in. main return pipe. The pressure is about 40 lbs. A circulation is maintained in the loops, thereby giving hot water at any point immediately upon opening the valve. This is done by a three-stage Lawrence centrifugal pump, located in the basement, and driven by a compound wound 10-h.p. General Electric motor, which operates continuously. The water pressure is determined by the quantity of the discharge, and to keep the pressure constant and thus keep the water circulating it is necessary to automatically regulate the speed of the pump. A solenoid governor varies the resistance in the shunt-field circuit of the motor, thereby maintaining better regulation than by the customary method of armature control. A variation of 10 per cent. in the speed of the pump will produce a variation of 3 to 1 in its output.

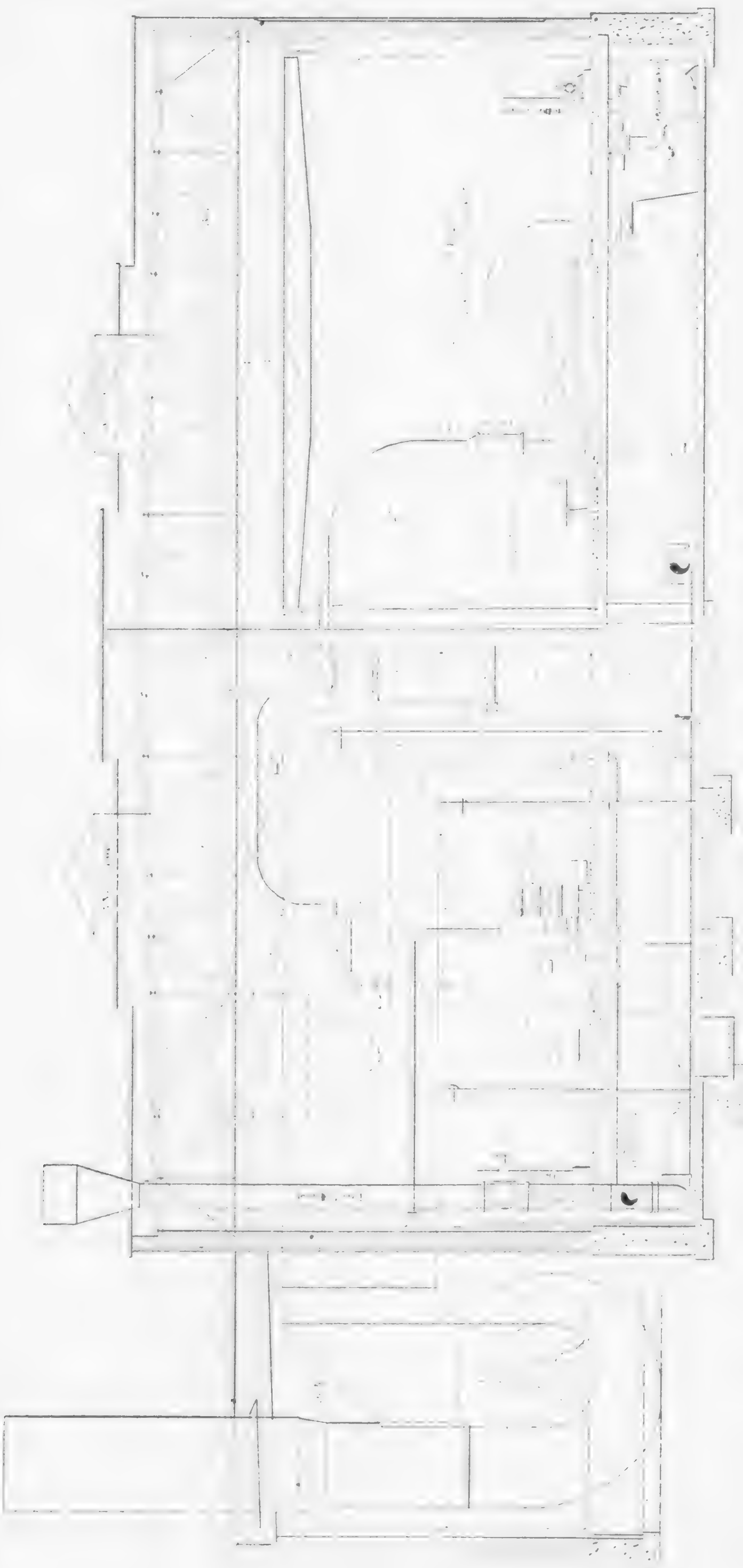
Heating System.—The exhaust steam is used for heating the buildings, the Webster vacuum return system being employed in connection with the Sturtevant system. This subject will be considered in detail in connection with the descriptfon of the equipment of the various buildings.

Switchboard.—The electrical load is divided into five classes of service supplied by eight feeders, as follows: cranes, 185 k.w.; heating fans, 245 k.w.; constant speed machine motors, 415 k.w.; variable speed machine motors, 175 k.w.; lighting (4 feeders), 189 k.w.; total, 1,209 k.w. Of these the first three are two-wire 230-volt lines, and the last two are three-wire 230-115-volt lines. The main switchboard has twelve panels, assigned as follows: 2, generators; 1, totalizing; 1, cranes and heating fans; 1, constant speed motors (to also carry wood-working machinery later); 2, balancer; 1, three-wire variable speed motors; 4, three-wire lighting. The load factors for maximum current demand on the various feeders were allowed as follows: Cranes, 800 amperes (arbitrarily determined); heating fans, 100 per cent., rated capacity; constant speed, 75 per cent. rated capacity; variable speed, 65 per cent., rated capacity; lighting, 100 per cent., rated capacity.

The lighting and variable speed motors are on the three-wire system and feed from the same balancer. Considerable trouble has been experienced in keeping the feeders balanced so as to avoid a fluctuation in the lights caused by the starting and stopping of the motors. To overcome this, the neutral bar bus has been divided in two sections, one for lighting and the other for variable speed motors. A switch is provided on the rear of the switchboard, so that the two sections may be connected together as one. With this arrangement one balancer is used for the lighting, while the other takes care of the variable speed motors. Through the day, with a small



ENGINE ROOM—EAST MOLINE SHOPS' POWER PLANT.



TRANSVERSE CROSS-SECTION THROUGH POWER HOUSE—EAST MOLINE SHOPS.

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sure. The more important fire hydrants are on the high-pressure line, but a number of fire hydrants are on the low-pressure line, and in case of fire the low-pressure tank is cut out and the high-pressure tank is connected to the low-service line.

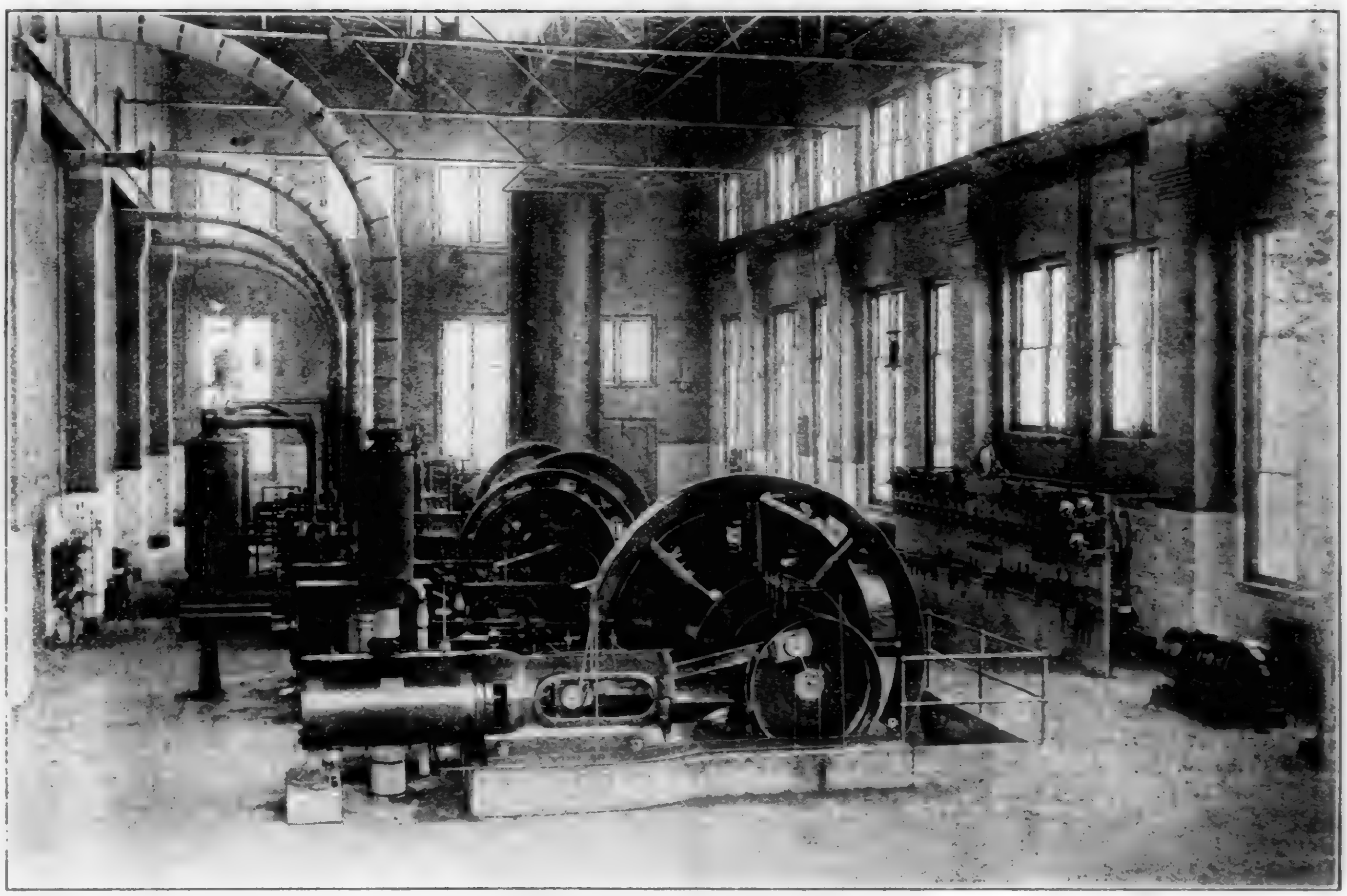
A Fairbank-Morse Underwriters' fire pump, capable of delivering 1,500 gals. per minute or 6¼ in. streams at 100 lbs. pressure, is located in the southwest corner of the power house basement. Water is obtained direct from supply main from the pumping station with the low-service tank connected as a reservoir on the pump intake. The discharge is connected direct to a 12-in. service main. In addition to this the storehouse is provided with a sprinkler system, which, by an arrangement of check valves, is constantly under pressure from the high-service tank, and is automatically put on fire pressure when underwriters' pump is in operation. In case of fire it is necesary to operate but two valves to put the entire water system under fire pressure. Steam for operating the pump is taken from the south end of main steam header in boiler room, and delivered to pump through a 5-in. direct separator. The pump is controlled by a Fisher governor. The water works system was installed by the Otto Gas Engine Company, Chicago.

Hot Water.—Hot water at 210 deg. Fahr. is supplied from the Webster feed water heater to all the buildings. The outgoing lead is 2½-in. pipe, and from the end of each branch a ¾-in. pipe leads to a 1-in. main return pipe. The pressure is about 40 lbs. A circulation is maintained in the loops, thereby giving hot water at any point immediately upon opening the valve. This is done by a three-stage Lawrence centrifugal pump, located in the basement, and driven by a compound wound 10-h.p. General Electric motor, which operates continuously. The water pressure is determined by the quantity of the discharge, and to keep the pressure constant and thus keep the water circulating it is necessary to automatically regulate the speed of the pump. A solenoid governor varies the resistance in the shunt-field circuit of the motor, thereby maintaining better regulation than by the customary method of armature control. A variation of 10 per cent. in the speed of the pump will produce a variation of 3 to 1 in its output.

Heating System.—The exhaust steam is used for heating the buildings, the Webster vacuum return system being employed in connection with the Sturtevant system. This subject will be considered in detail in connection with the description of the equipment of the various buildings.

Switchboard.—The electrical load is divided into five classes of service supplied by eight feeders, as follows: cranes, 185 k.w.; heating fans, 245 k.w.; constant speed machine motors, 415 k.w.; variable speed machine motors, 175 k.w.; lighting (4 feeders), 189 k.w.; total, 1,209 k.w. Of these the first three are two-wire 230-volt lines, and the last two are three-wire 230-115-volt lines. The main switchboard has twelve panels, assigned as follows: 2, generators; 1, totalizing; 1, cranes and heating fans; 1, constant speed motors (to also carry wood-working machinery later); 2, balancer; 1, three-wire variable speed motors; 4, three-wire lighting. The load factors for maximum current demand on the various feeders were allowed as follows: Cranes, 800 amperes (arbitrarily determined); heating fans, 100 per cent., rated capacity; constant speed, 75 per cent. rated capacity; variable speed, 65 per cent., rated capacity; lighting, 100 per cent., rated capacity.

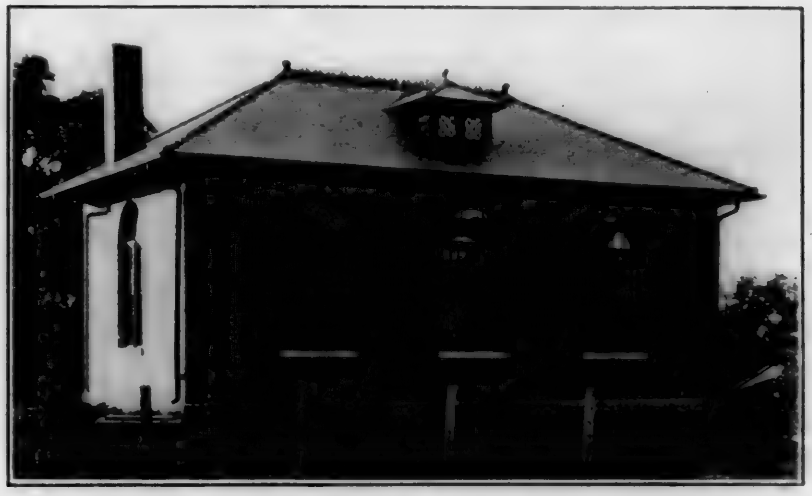
The lighting and variable speed motors are on the three-wire system and feed from the same balancer. Considerable trouble has been experienced in keeping the feeders balanced so as to avoid a fluctuation in the lights caused by the starting and stopping of the motors. To overcome this, the neutral bar bus has been divided in two sections, one for lighting and the other for variable speed motors. A switch is provided on the rear of the switchboard, so that the two sections may be connected together as one. With this arrangement one balancer is used for the lighting, while the other takes care of the variable speed motors. Through the day, with a small



ENGINE ROOM—EAST MOLINE SHOPS' POWER PLANT.

lighting load, this fluctuation is of little importance; the switch on rear of board is closed, and the lighting and motors supplied from the same balancer. In the evening, when the lighting load increases, both balancers are used, and the switch on the rear of the board is opened, so that the lighting and variable speed motors are then independent of each other. The result of this change is very noticeable in the life of lamps, besides a much improved lighting service.

Tunnels.—A tunnel which carries the electric wires and piping leads from the power house to the various buildings. It is 6 ft. 6 ins. high and 6 ft. wide at the power house and 5 and 4 ft. wide at other points, according to the demand for space. The tunnel is concrete, and the roof is 6 ins. thick, reinforced by expanded metal. At points where tracks in the yard cross the tunnel the roof is strengthened by old rails



PUMPING PLANT—EAST MOLINE SHOPS.

laid crosswise. At suitable intervals openings 2 ft. 8 ins. wide and 8 ft. long are located for the purpose of introducing lengths of pipe. These openings are covered by substantial grids. The aggregate length of the tunnel is 2,120 ft., and suitable provision is made for ventilation and drainage. The pipes are carried at one side and the electric wires at the other. At intervals of 6 ft. upright pieces of 6 by 4-in. oak are set into the concrete sides, and cast iron brackets, which carry cast iron chairs for the pipes, or glass insulators for the wires, are secured to them by lag screws.

Lockers and toilet arrangements for the power house force are provided in one corner of the boiler room.

We are indebted for information and drawings to Mr. C. A. Seley, mechanical engineer, and Mr. C. H. Wilmerding, consulting engineer, of Chicago.

Locomotive Testing Plant.—A locomotive testing laboratory is to be built in Germany at the Grunewald Works, on similar lines to that at the St. Louis Exposition. It is to be in charge of the well-known locomotive designer, Professor Von Borries.

Electrification of the Duluth, Missabe & Northern Railway.—It is reported that as soon as possible this road will adopt electricity as a motive power. The plans will probably include the use of electrical apparatus for unloading the large steel ore cars at the docks.

Shop Telephone Systems.—One of the most valuable adjuncts to a well-organized shop is a telephone system for every foreman, and if it were possible to figure accurately the time so saved every railroad shop of medium or large size would be equipped with a telephone system. If the shop was quite small—handling only three or four engines—it might not be a good investment, but in any shop holding five or more engines it will give large returns.—*Mr. M. K. Barnum, before the Western Railway Club.*

STEEL CAR DEVELOPMENT.

Pennsylvania Railroad.

VIII.

(*For previous Article See Page 358.*)

FLAT AND GONDOLA CARS.

The class designated as Fm is a very strong flat car of 100,000 lbs. capacity, built of steel with a wooden floor, and having stake pockets. It is built for concentrated loads which in this series of cars provide for carrying two-thirds of the capacity of the car on a line across the floor or anywhere between the cross bearers. The Fm and Gr classes are both built for such loads, while the Gs classes, of which there are four, Gs, Gsa, Gsb, Gsc, are built for uniformly distributed loads.

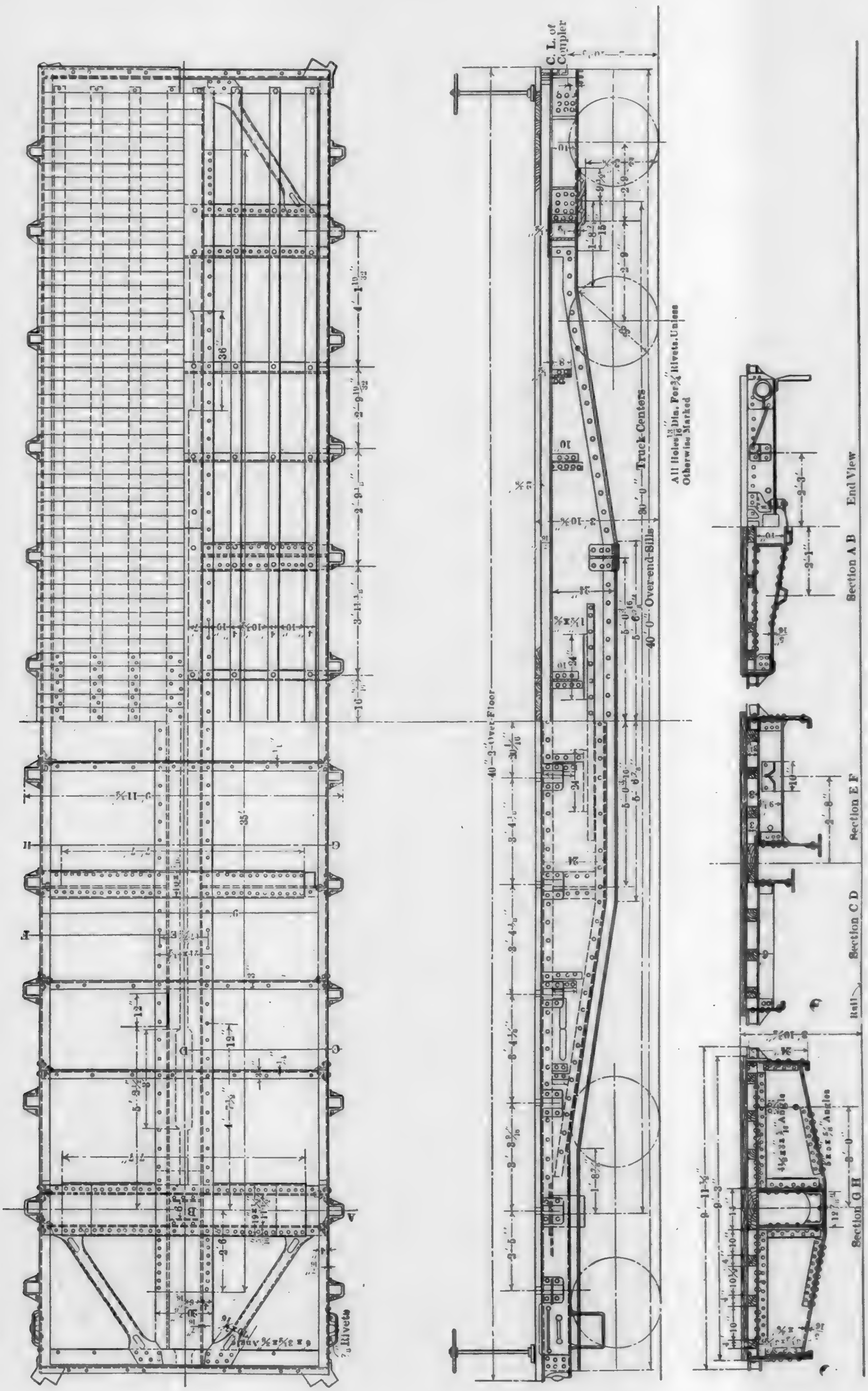
The Fm car has pressed steel center sills 24 ins. deep at the center and 10 ins. deep at the bolsters. These are reinforced by angles at the lower flanges and they are covered with a 21 by ½ in. cover plate, which extends between the bolsters and to a distance of 2 ft. 6 ins. beyond the bolsters at each end. The side sills are also pressed steel channels 24 ins. deep, with their lower and upper flanges reinforced with angles extending between the bolsters. The upper flanges of the side sills are higher than those of the center sills, they turn in just under the flooring while the floor stringers rest upon the cover plate of the center sills at the center of the car. The drawings illustrate the construction of the bolsters, the end sills and the large cross bearers, two of which cross the frame between the bolsters. The cross bearers have 10 by 7-16 in. cover plates. In addition to these the floor is also supported by smaller cross bearers of 10 and 8 in. pressed channels, as indicated in the drawings of the Fm car. In the engravings the section at A-B shows one of the cross bearers and E-F shows a bolster and end sill. The general plan of the frame illustrates the corner bracing and the substantial gussets and cover plates over the bolsters. The Fm car weighs 40,000 lbs. for a capacity of 100,000 lbs.

With a length of 40 ft. and concentrated loads the neutral axis of the sills would be too low and the strength insufficient unless the pressed steel channels were reinforced by angles at the bottom and, in the case of the side sills, angles also at the top and cover plates over the center sills. The side sills of the Fm car are each designed to carry about one-sixth of the total load.

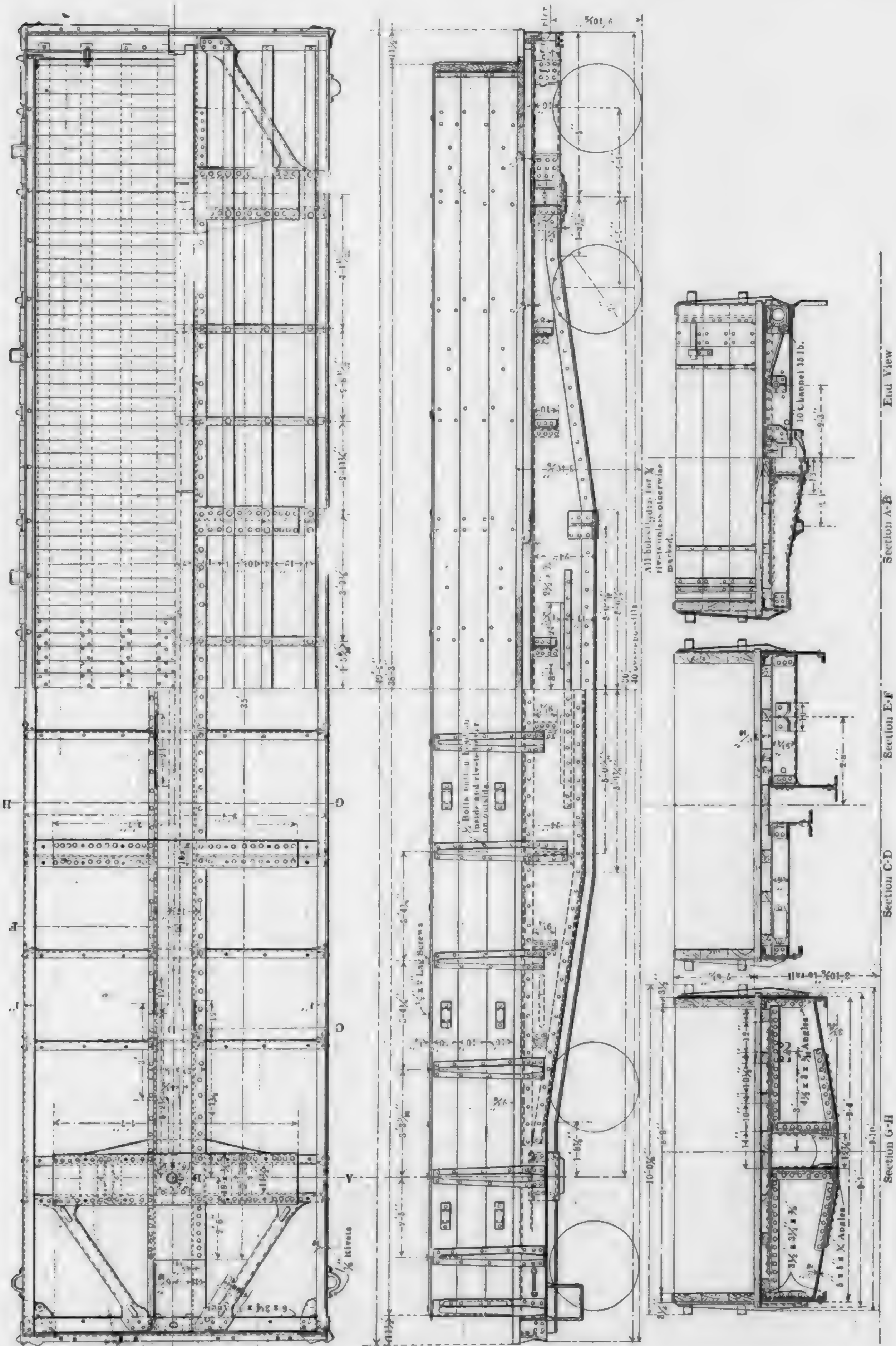
The Gr class, also built for concentrated loads, has steel underframing and wooden gondola sides, with pressed steel stakes. This car is as wide as it could be built and the members of the underframe are generally similar to those of the Fm class. This class is also 40 ft. long. The inside dimensions are 37 ft. 8¼ ins. by 8 ft. 9 ins., and the sides are 30 ins. high.

It is to be noted that the wooden sides are made 3½ ins. thick, and the height limited to 30 ins. This is for the purpose of better adapting the car for carrying top loads of long structural material, the car being primarily designed to serve the steel mill district, where such top loads are becoming more and more frequent and where long loads on top of high sides are objectionable.

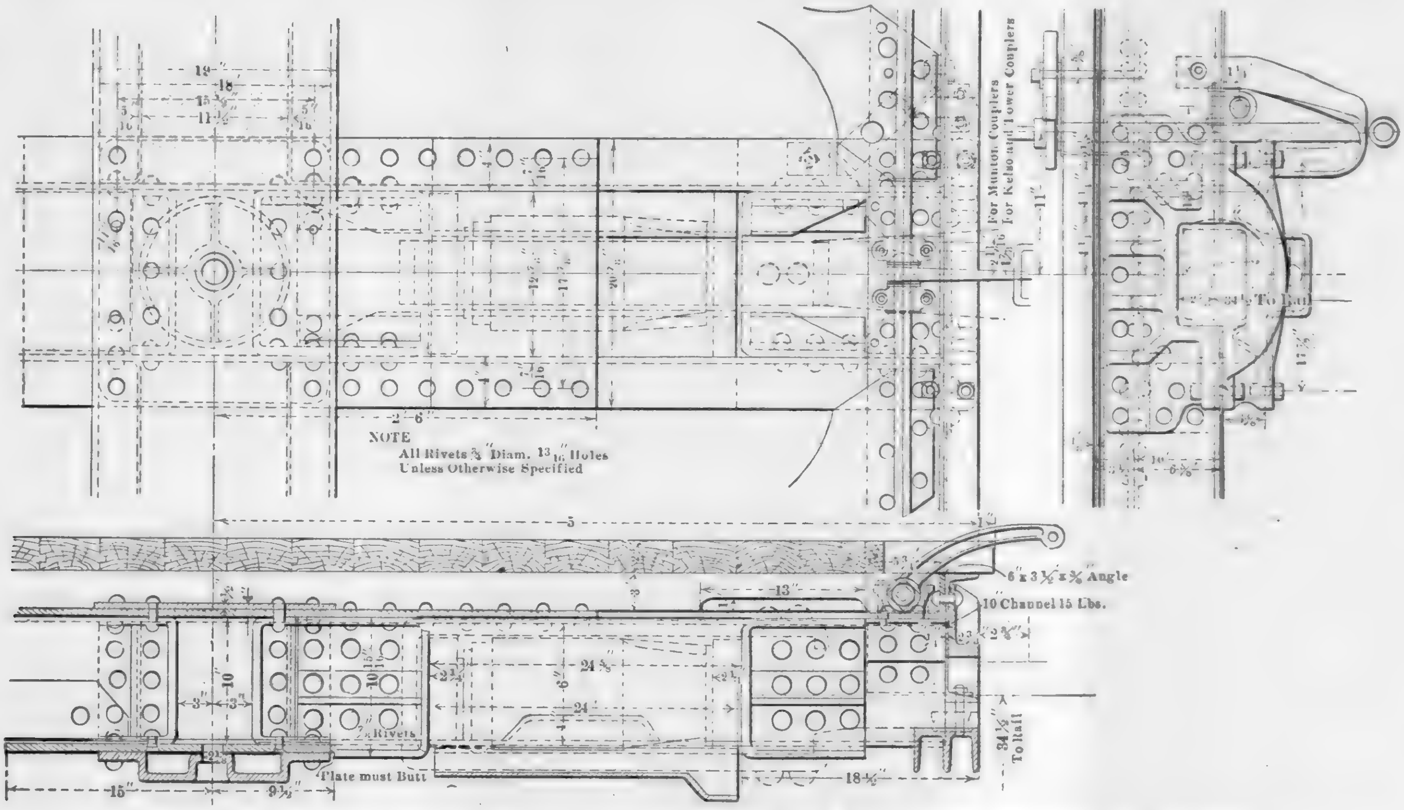
These cars weigh 44,000 lbs. and carry 100,000 lbs., making the ratio of dead weight to paying load 44 per cent. These cars have drop ends. They are fitted with Westinghouse friction draft gear, the arrangement of which is indicated in the detail engraving which applies to both the Gr and the Fm classes. This draft attachment has been found perfectly satisfactory in service on a large number of steel cars.



50-TON STEEL FLAT CAR, CLASS FM—PENNSYLVANIA RAILROAD.



50-TON LOW SIDE GONDOLA CAR, WOODEN SIDES, CLASS GR—PENNSYLVANIA RAILROAD.



APPLICATION OF WESTINGHOUSE FRICTION DRAFT GEAR TO FM AND GR CLASSES—PENNSYLVANIA RAILROAD.

CLASSIFICATION OF LOCOMOTIVES FOR TONNAGE RATING PURPOSES.

MR. J. H. LONIE.

In a paper on "A Standard Locomotive Classification," presented before the Master Mechanics' Association in 1901, Mr. R. P. C. Sanderson suggested stenciling on the cabs the hauling capacity of the locomotive in tons on a straight level track at ten miles per hour, together with a letter suggestive of the type of locomotive in question. As these figures would be too long for current use, and as minute refinement is not necessary, it was suggested that the first two figures, representing hundreds, would be sufficient. Thus, a 10-wheel engine capable of hauling 3,700 tons on a straight level track at ten miles per hour would be stencilled T-37. A modification of this system has been successfully used on the Rock Island System for the convenience of the transportation department in loading engines.

The tractive power of each group of engines on the system was first calculated in even thousand pounds (500 lbs. and over being considered as 1,000, and less than 500 lbs. being disregarded), and the tractive power in thousands was then stencilled on the cab together with a letter indicating the type. These letters were chosen more with reference to easy telegraphing than as suggesting types, and are as follows: Simple engines—8-wheel, B; 10-wheel, D; consolidation, C; Atlantic, A; Pacific, N; Mogul, G; suburban, K; 4-wheel switch, H; 6-wheel switch, J. Compound engines—10-wheel, F; consolidation, Q; Atlantic, W. This is known as the road classification and is entirely independent of the motive power classification. Thus, we have 8-wheel engines, from 10,000 to 19,000 lbs. tractive power, known as road class B-10, B-11, B-12, etc.; 10-wheel engines, road class D-14 to D-31; consolidation engines, road classes C-25 to C-40, etc. It was thought preferable to have the two entirely separate classifications rather than to attempt to combine both in one. It is evident that there may be several groups of engines of the same type and tractive power, but differing from each other in detail and each requiring a separate class for the use of the motive power department in ordering repairs, identifying drawings, etc. The transportation department is not interested in these minor differences, and by combining all engines of the same type and tractive power in one group, the number of road classes is greatly reduced. A combined classification is likely to be cumbersome, a burden to the memory and difficult to introduce on a system already having a motive power classification in regular use, while the road classification can be introduced without disturbing the present state of affairs.

The road classification symbols, when once comprehended, give a relative idea of the type and power of the engine, which is mainly what the transportation people want. If they wish to know the motive power class, size of wheels, or other special information, they may get it from the classification register. If a new engine comes on a division, the transportation officials know its tonnage capacity by its road class, though they may have never seen an engine like it before. Engine numbers may be changed so often that their identity is lost, yet so long as the stenciling on the cab remains unchanged, the engine may be properly rated, and no change is necessary in the tonnage rating sheets. The tonnage rating book for each division (the sheet for the division from St. Joe to Fairbury is reproduced) has the columns headed by Nos. 10, 11, 12, etc., up to the highest tractive power of the engines used on the division. The figures in the vertical columns show the rating over the entire division, and this, of course, corresponds to that of the section having the ruling grade for the division. These books show the normal or first rating only, and ratings for wet or stormy weather, fast stock trains, etc., are taken as a fixed percentage of the first or normal rating and an arbitrary allowance made for empty cars.

In making up the ratings, a table was first prepared showing the hauling capacity in tons for each of the different tractive powers and the different grades beginning at zero and advancing by tenths of one per cent. From this table a second was prepared, showing the hauling capacity behind the tender; by substracting from the numbers in the first the *average* weight of all engines, including the tender, having the same tractive power. As an example, from the first table we find that an engine of 19,000 lbs. tractive power would pull on a 1.3 per cent. grade 595 tons. It was found that there were on the system both 8-wheel engines, road class

B-19, and 10-wheel engines, road class D-19, having 19,000 lbs. tractive power. The average weight of these engines is 100 tons. Deducting 100 tons from 595 tons gives 495 tons as the haulage capacity for all engines in road class 19, of whatever type, on a 1.3 per cent. grade.

It is evident that this method of grouping all engines of the same tractive power together, regardless of type, is an advantage to engines which are relatively light for their service, they may be given a lower road class than their tractive power would indicate. Thus, a Pacific type engine with its tender weighing 334,000 lbs. may have a tractive power of, say, 27,800 lbs., and would ordinarily be classified as road class N-28. It may be, however, that there are 10-wheel engines on the road weighing 250,000 lbs. and having a tractive power of 28,400, and these would be classified as D-28. It is evident that the Pacific type engine would stall with a load

NEBRASKA DIVISION

ST. JOE-FAIRBURY LINE

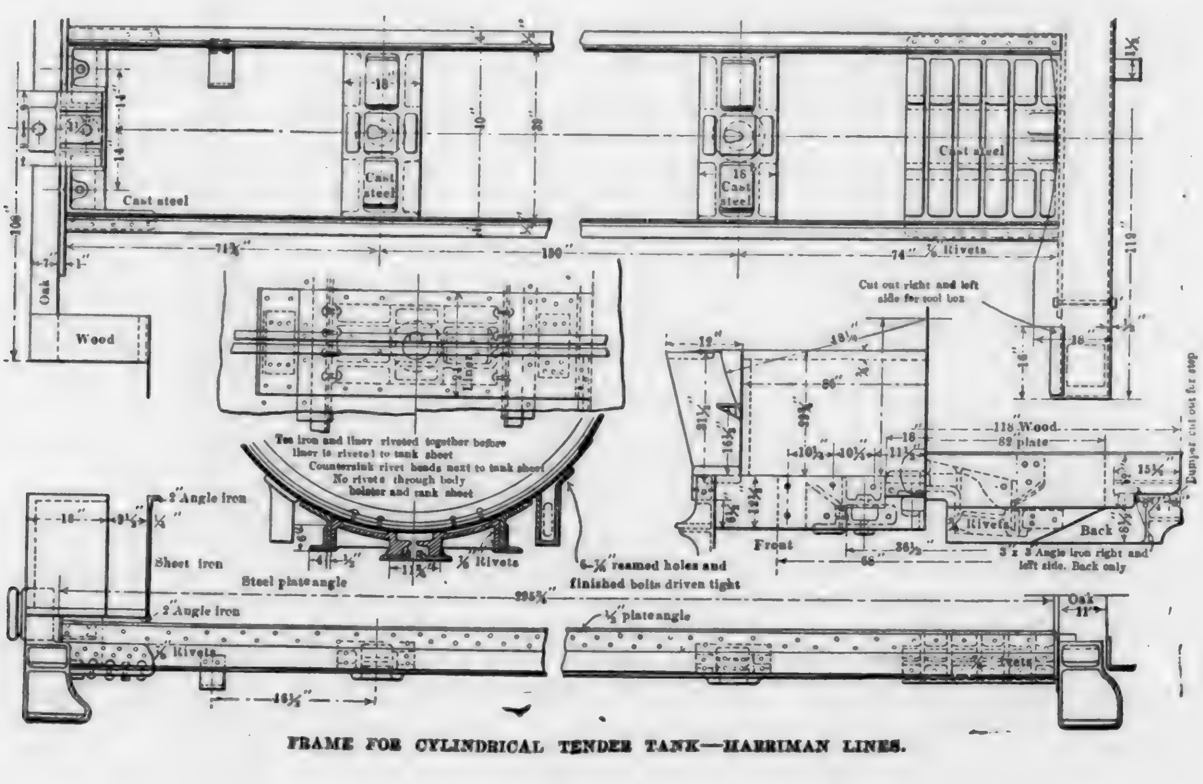
WESTWARD	ROAD CLASS OF ENGINE																				
	39	31	30	[illegible]	28	27	26	25	24	23	22	21	[illegible]	[illegible]	18	17	16	15	14	13	12
ST. JOE TO HORTON	1560	1230	1185	1140	1110	1065	1040	995	[illegible]	915	870	825	775	740	705	675	615	580	[illegible]	505	465
HORTON " VIRGINIA	1335	1050	1010	975	945	910	890	850	785	780	745	705	660	630	600	575	525	[illegible]	465	430	395
VIRGINIA " BEATRICE	2630	2070	2000	1930	1870	1800	1740	1675	1575	1535	1470	1395	1320	1257	1195	1135	1065	990	925	860	785
BEATRICE " ELLIS	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
ELLIS " FAIRBURY	2275	1795	1735	1670	1620	1560	1515	1450	1360	1330	1270	1210	1140	1085	1030	985	910	855	800	740	685
	1335	1050	1010	975	945	910	890	850	785	760	745	705	660	630	600	575	525	495	465	430	395
EASTWARD																					
FAIRBURY TO DU BOIS	1395	1100	1060	1020	[illegible]	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
DU BOIS " HORTON	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
HORTON " ST. JOE	1610	1265	1220	1175	1140	1100	1070	1025	950	940	895	850	800	765	725	695	640	600	565	520	480

SHEET FROM TONNAGE RATING BOOK—ROCK ISLAND SYSTEM.

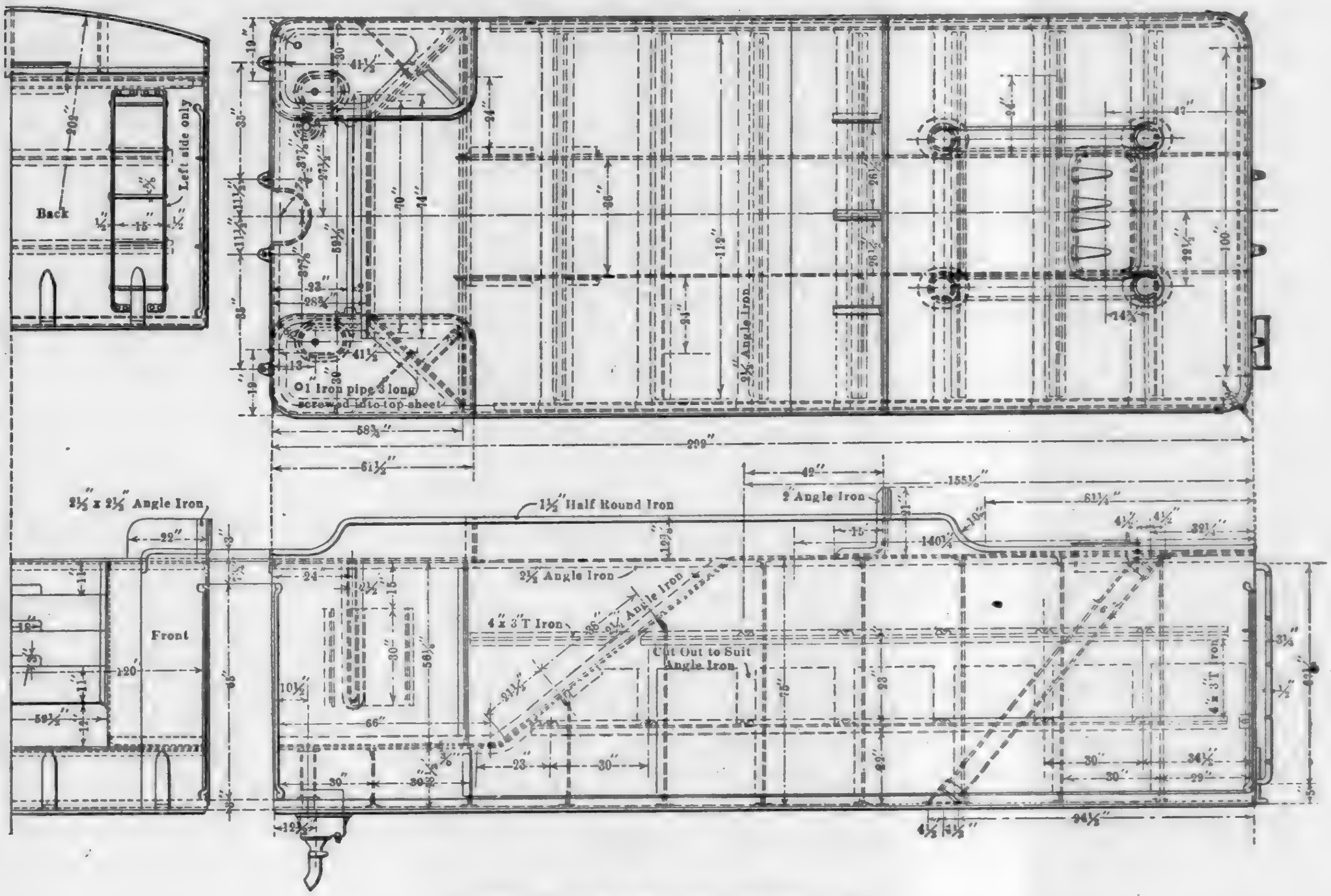
tractive power, while it is a disadvantage to those which are relatively heavy, since the same reduction for weight of engine and tender is made for both, unless the variation of weight is considerable, however, the percentage of error will not be great. Moreover, in getting the average weight of a group, switch engines, which are not ordinarily used to haul trains on the road, and Atlantic and Pacific type engines, which are usually used in passenger service, may be left out of consideration. If Atlantic or Pacific type engines, or other types, with high wheels and small tractive power in proportion to their weight, ordinarily used in passenger service, are to be used in freight service, which the 10-wheeler would easily haul, and the Pacific type engine may properly be classed as N-27.

In making up the tonnage rating books, the ruling grade for each section is first determined and the rating for the different classes taken direct from the second table mentioned above. If there are sharp curves on ruling grades the resistance due to the curve may be reduced to its equivalent in percentage of grade.

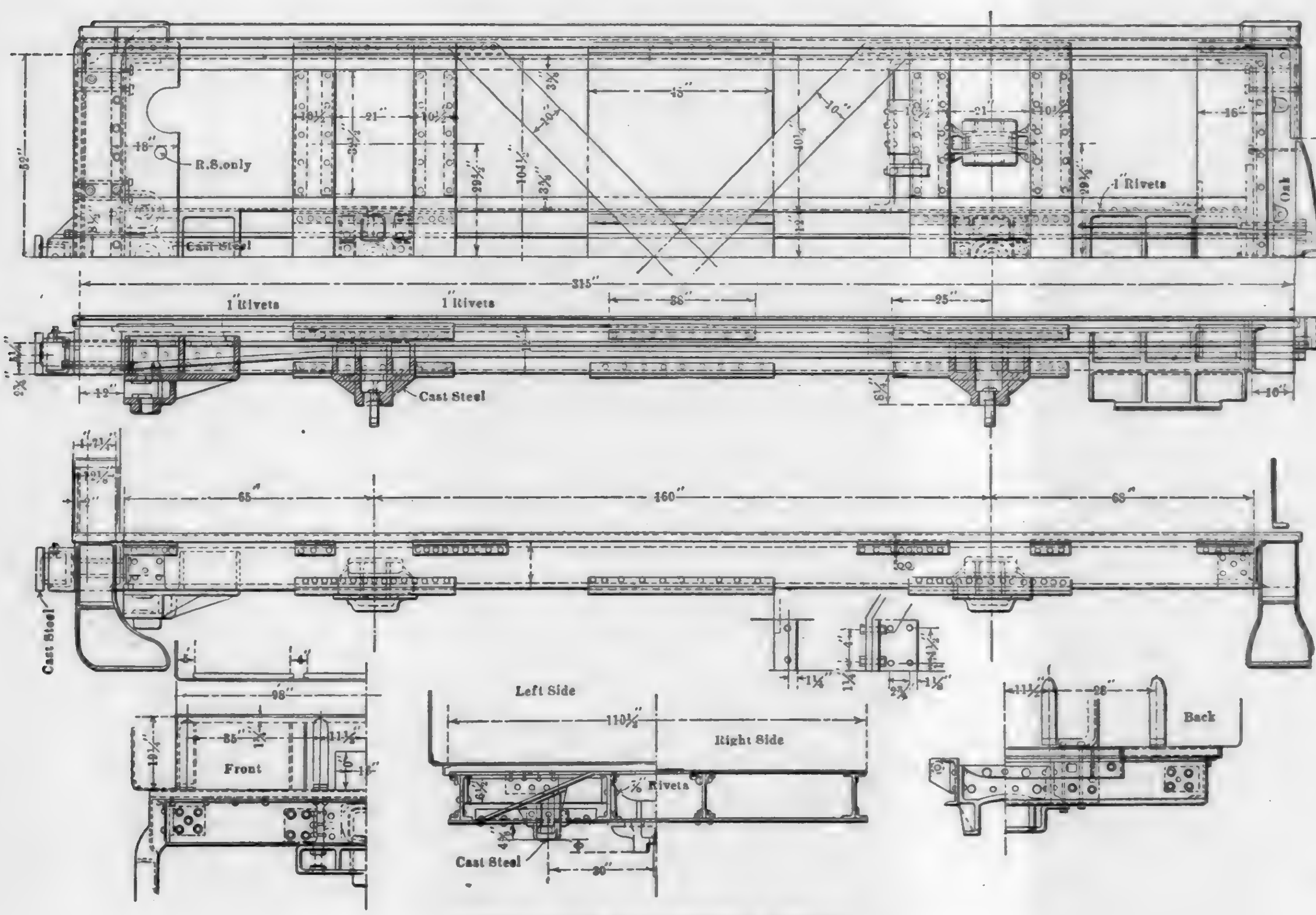
This method of classifying and rating engines is of particular advantage on a system made up of several smaller lines or systems and having a mixed equipment.



FRAME FOR CYLINDRICAL TENDER TANK—HARRIMAN LINES.



TENDER TANK FOR PASSENGER ENGINES.



TENDER FRAME FOR PASSENGER ENGINES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

VIII.

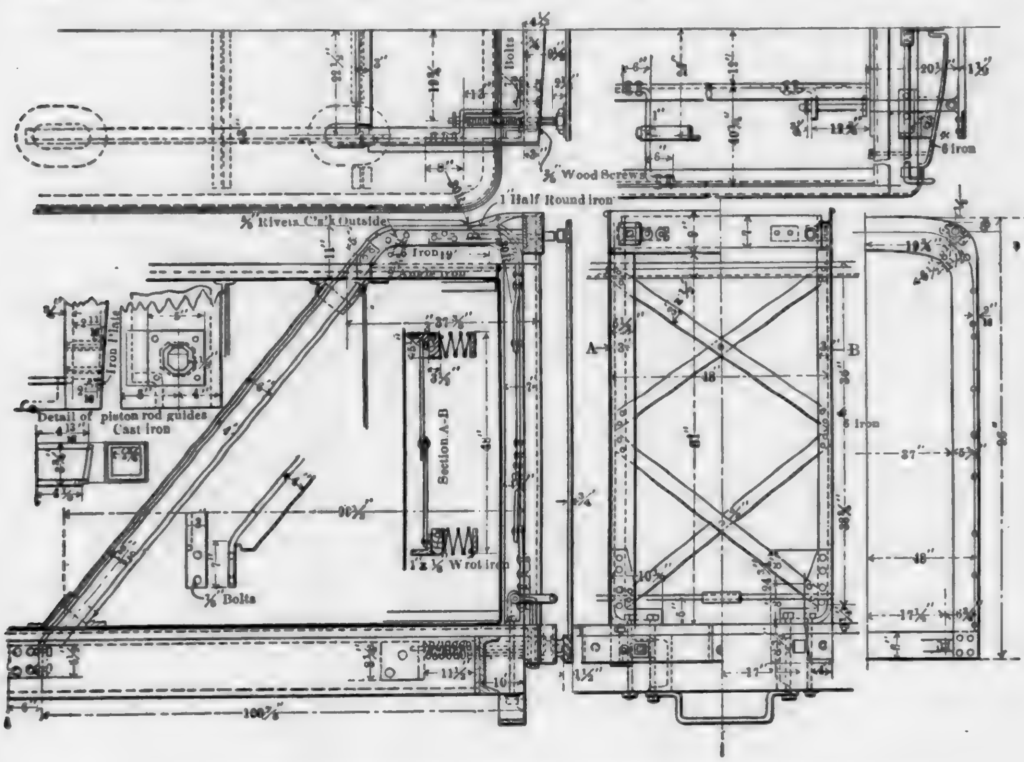
(*For previous articles see pages* 154, 200, 250, 288, 322, 353 *and* 400.)

TENDERS.—The freight locomotives have Vanderbilt tenders with a capacity for 7,000 gals. of water and 14 tons of coal. These tenders are frameless as the illustrations indicate. It was originally intended to employ this type of tender for all common standard locomotives except the switching class. In accordance with a latter decision the rectangular form was adopted for the passenger locomotives. The Vanderbilt tenders are built with a ⅝-in. plate, extending the full length of the tank at the bottom, and this is made specially wide to keep riveted joints entirely out of the way of shock of the draft and buffing stresses. Cast steel bolsters and draft castings are secured between ½-in. steel plate sills, which are bent into the form of angles and riveted to the body of the tank and to heavy longitudinal angles, as indicated in the drawing.

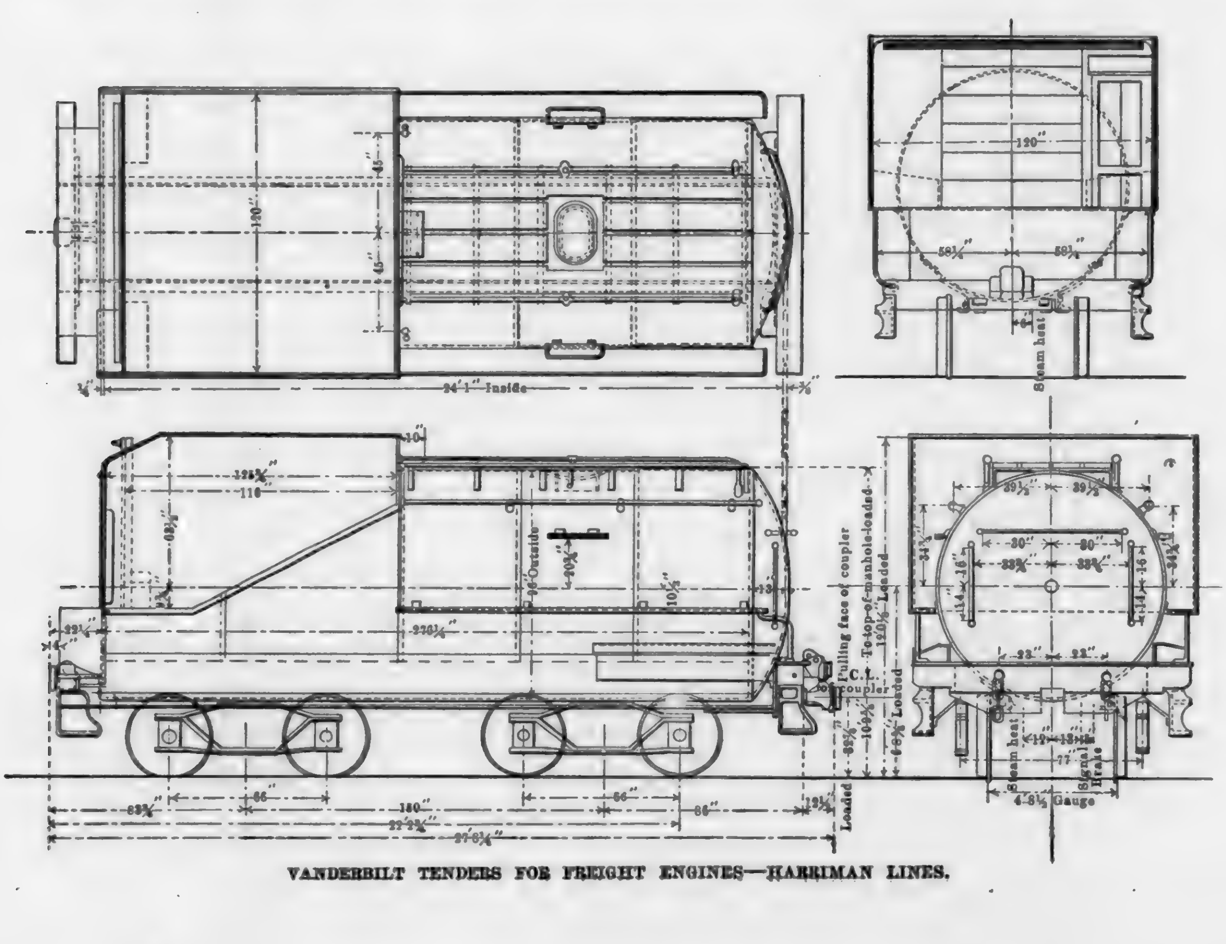
TENDERS OF PASSENGERS LOCOMOTIVES.—For passenger service very large tenders with a capacity of 9,000 gals. of water and 10 tons of coal were adopted. These are believed to be the largest tenders used in regular passenger equipment. The frames are of 12-in. channels for side, center and end sills. To the end sills, oak timbers are secured. The framing drawing illustrates the cast steel center plates and the transverse and diagonal bracing plates, which are riveted on top of and beneath the sills. The draft castings are of cast steel.

These tenders are fitted with vestibule diaphragms, the frames of which are rigidly connected to the tender frames and braced by angles in 6-in. pipe passing down through the water in the tank.

The total height of the



VESTIBULE ARRANGEMENT FOR PASSENGER ENGINE TENDER—HARRIMAN LINES.



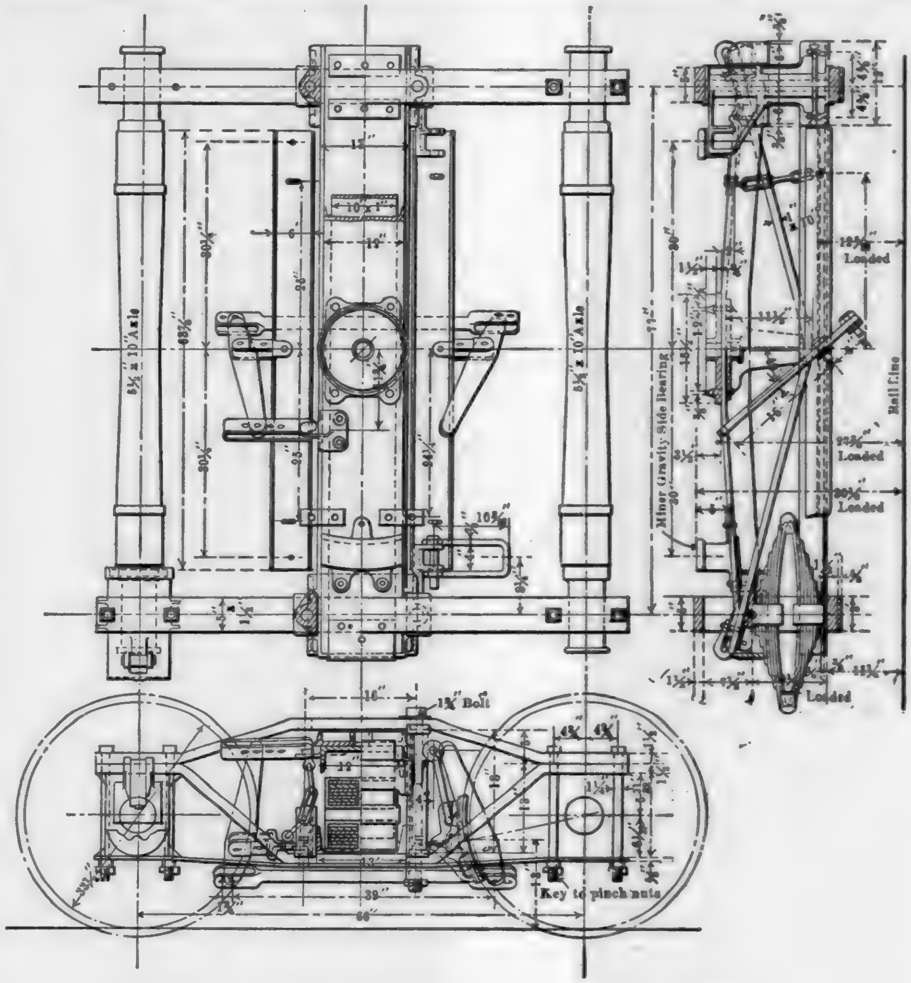
VANDERBILT TENDERS FOR FREIGHT ENGINES—HARRIMAN LINES.

tender over the coal board is 147¾ in. The total height from the rail to the top of the manhole ring is 130 ins. The total wheel base of the tender is 160 ins. The length of the tank is 229 ins. The tank has a water bottom with a depth of 18½ ins. under the coal space in front. At each side liberal tool boxes are provided. The tank bracing is in the form of angles and plates.

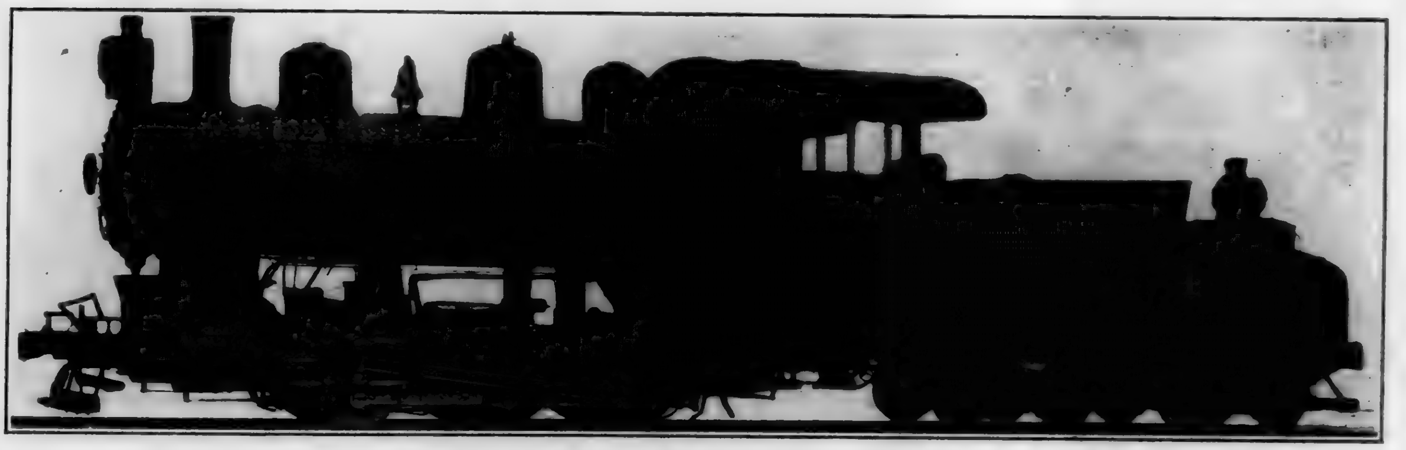
The tenders for the switchers are of ordinary construction with 10-in channel sills, weighing 30 lbs. per ft. The tank slopes towards the rear and the construction is in no way unusual.

TENDER TRUCKS.—These trucks are of the diamond arch bar type with Simplex bolsters. The drawings show the size of the various parts and the channel frames. The trucks for both road and switch engines have inside hung brakes. All road engines 5½ by 10 in. standard M. C. B. tender axles, and the switchers have 4¼ by 8 in. The center plates are of cast steel and M. C. B. contour. The tenders of the switchers have a water capacity of 4,000 gals. and a coal capacity of 5 tons. All of the tenders have Miner gravity side bearings.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Works in supplying the drawings.



TENDER TRUCK FOR FREIGHT ENGINES—HARRIMAN LINES.


SIX-WHEEL SWITCHING LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

SIX-WHEEL SWITCHING LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

The accompanying photograph illustrates one of a number of switching locomotives recently constructed for the Chicago, Rock Island & Pacific Railway at the Richmond works of the American Locomotive Company. Since the presentation of the report of the Power Committee of the Rock Island System a large number of locomotives have been ordered, which, while varying slightly from the detailed dimensions recommended by that committee, follow in general the plan which was presented in outline in this journal in March, page 84. The Baldwin Locomotive Works have built ten switching locomotives, thirty-eight 4—6—0 locomotives with Walschaert valve gear and two 4—4—2 balanced compounds. The American Locomotive Company have built twenty six-wheel switching locomotives, ten 4—4—0 passenger locomotives of which two are supplied with superheaters, twenty 4—6—2 passenger locomotives of which four have superheaters, and fifteen 4—6—0 locomotives for fast freight and passenger service. The Atlantic, Pacific and ten-wheel designs have already been illustrated in this journal, the present description completing the first series built in accordance with the suggestions of the Power Committee. This locomotive has 10¼-in. piston valves with direct valve motion and inside admission. The cylinders are 19 by 26 ins. Driving wheels, 51 ins. in diameter, which, with 200 lbs. boiler pressure, gives a tractive effort of 31,300 lbs. Additional features are presented in the accompanying table.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

VIII.

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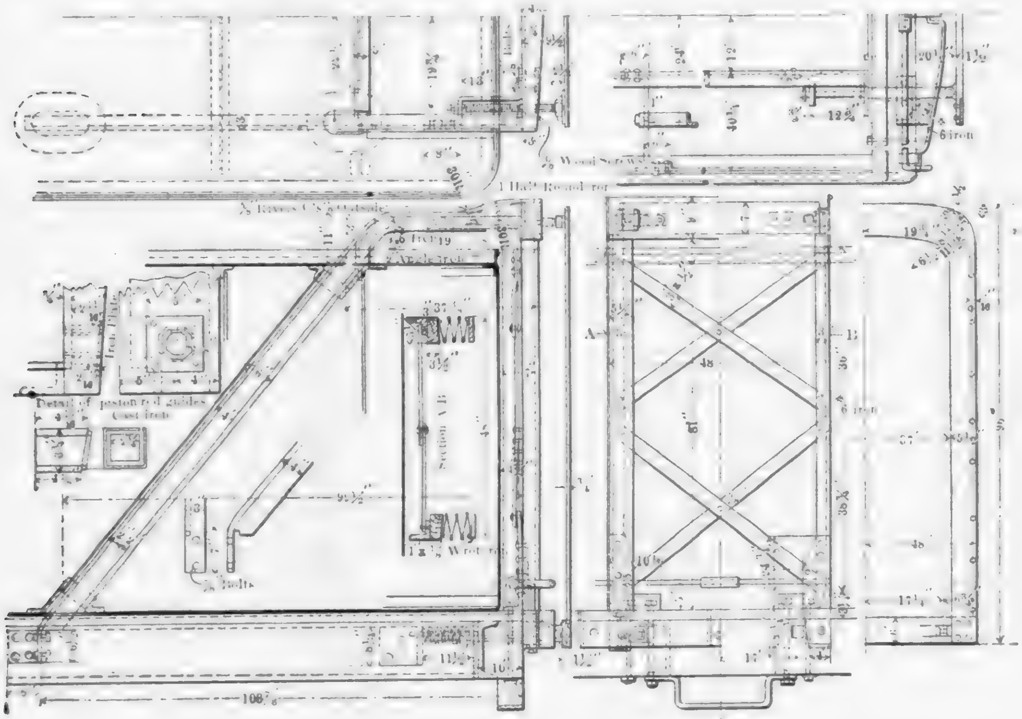

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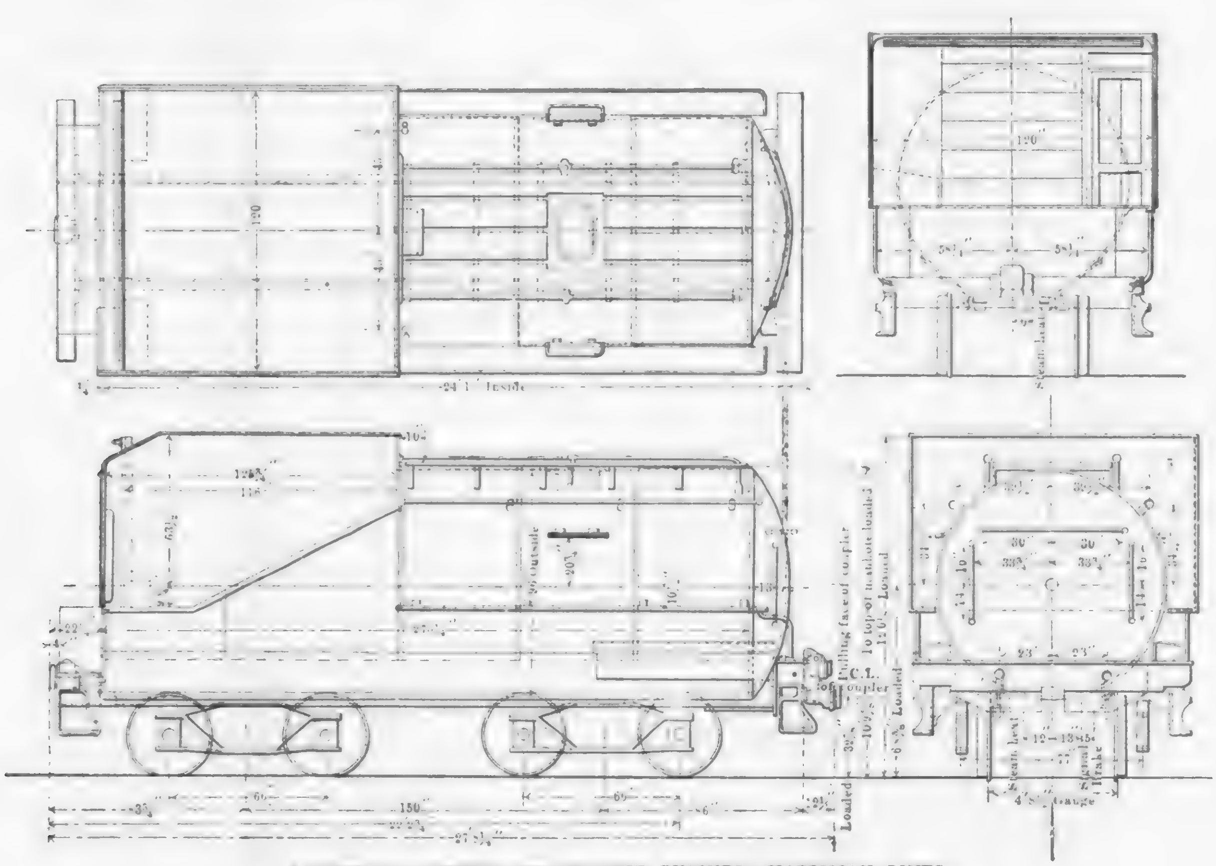


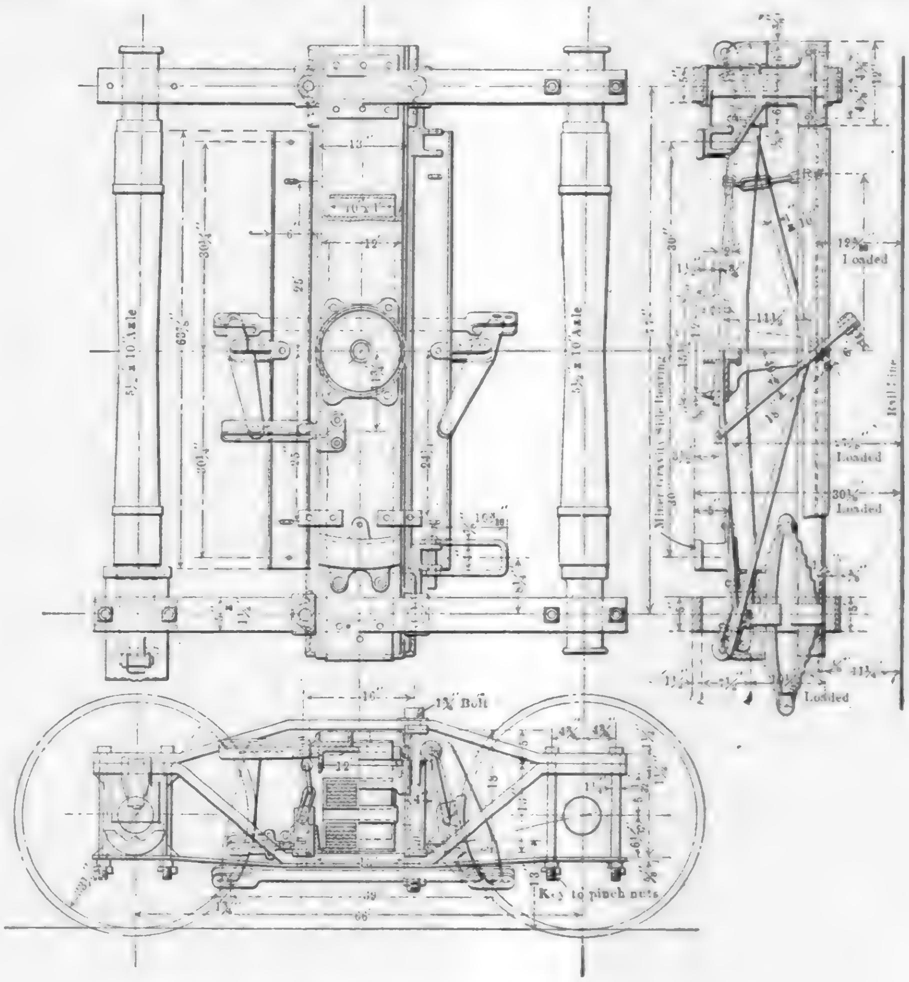
VANDERBILT TENDERS FOR FREIGHT ENGINES—HARRIMAN LINES.

tender over the coal board is 147¾ in. The total height from the rail to the top of the manhole ring is 130 ins. The total wheel base of the tender is 160 ins. The length of the tank is 229 ins. The tank has a water bottom with a depth of 18½ ins. under the coal space in front. At each side liberal tool boxes are provided. The tank bracing is in the form of angles and plates.

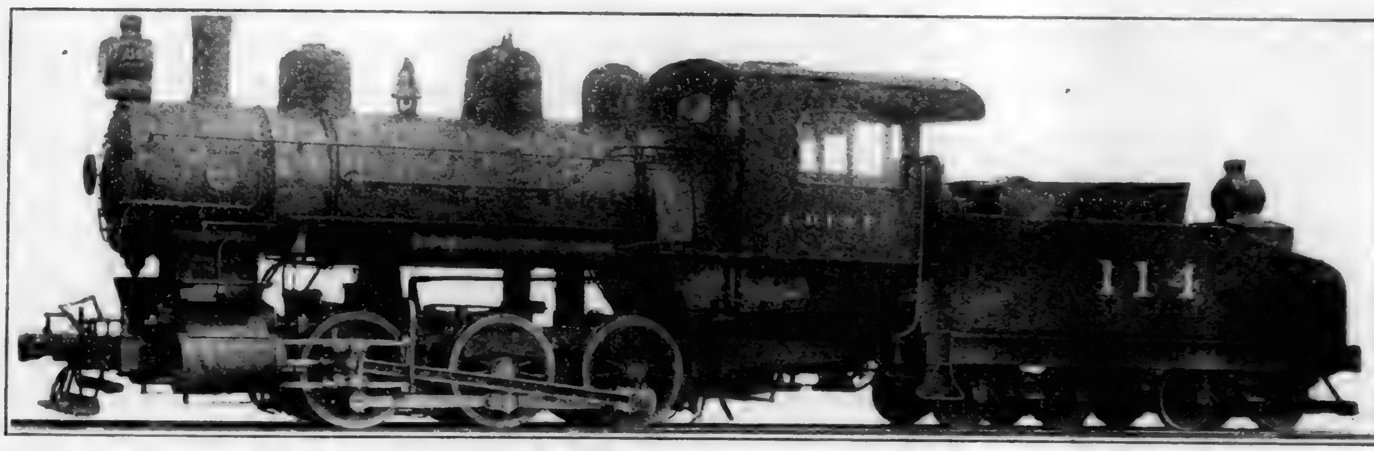
The tenders for the switchers are of ordinary construction with 10-in channel sills, weighing 30 lbs. per ft. The tank slopes towards the rear and the construction is in no way unusual.

Tender Trucks.—These trucks are of the diamond arch bar type with Simplex bolsters. The drawings show the size of the various parts and the channel frames. The trucks for both road and switch engines have inside hung brakes. All road engines 5½ by 10 in. standard M. C. B. tender axles, and the switchers have 4¼ by 8 in. The center plates are of cast steel and M. C. B. contour. The tenders of the switchers have a water capacity of 4,000 gals. and a coal capacity of 5 tons. All of the tenders have Miner gravity side bearings.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Works in supplying the drawings.



TENDER TRUCK FOR FREIGHT ENGINES—HARRIMAN LINES.



SIX-WHEEL SWITCHING LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

SIX-WHEEL SWITCHING LOCOMOTIVE.

Chicago, Rock Island & Pacific Railway.

The accompanying photograph illustrates one of a number of switching locomotives recently constructed for the Chicago, Rock Island & Pacific Railway at the Richmond works of the American Locomotive Company. Since the presentation of the report of the Power Committee of the Rock Island System a large number of locomotives have been ordered, which, while varying slightly from the detailed dimensions recommended by that committee, follow in general the plan which was presented in outline in this journal in March, page 84. The Baldwin Locomotive Works have built ten switching locomotives, thirty-eight 4—6—0 locomotives with Walschaert valve gear and two 4—4—2 balanced compounds. The American Locomotive Company have built twenty six-wheel switching locomotives, ten 4—4—0 passenger locomotives of which two are supplied with superheaters, twenty 4—6—2 passenger locomotives of which four have superheaters, and fifteen 4—6—0 locomotives for fast freight and passenger service. The Atlantic, Pacific and ten-wheel designs have already been illustrated in this journal, the present description completing the first series built in accordance with the suggestions of the Power Committee. This locomotive has 10¼-in. piston valves with direct valve motion and inside admission. The cylinders are 19 by 26 ins. Driving wheels, 51 ins. in diameter, which, with 200 lbs. boiler pressure, gives a tractive effort of 31,300 lbs. Additional features are presented in the accompanying table.

SIX-WHEEL SWITCHING LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

GENERAL DIMENSIONS.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal.
Weight on drivers	138,500 lbs.
Weight in working order	138,500 lbs.
Wheel base, driving	11 ft.
Wheel base, total engine and tender	41 ft. 10 ins.
Total length of engine and tender	57 ft. 9½ ins.

CYLINDERS

Diameter	19 ins.
Piston stroke	26 ins.
Piston packing	Plain rings.
Piston rod diameter	3½ ins. Material Steel.
Piston rod packing	U. S. metallic.
Steam ports	2⅛ ins.

VALVES.

Style	Piston valve.
Greatest travel	5 21/32 ins.
Lap outside	......
Lap inside	1 in.
Lead in full gear	......

WHEELS.

Driving, number	6
Driving, diameter	51 ins.
Driving centers, material	Cast Iron.
Driving box, material	Cast steel.
Driving axle journal	9 ins. by 12 ins.
Crank pin, main	5½ ins. by 6 ins.
Crank pin, side rods	4½ by 3½ and 5 ins. by 4½ ins.

BOILER.

Type	Straight top, wide firebox.
Working pressure	200 lbs.
Outside diameter, first course	62½ ins.
Thickness of plates, in barrel	⅝ in.
Thickness of plates	9-16 and ½ in.
Seams, circumferential	Double riveted.
Seams, horizontal	Butt joint, sextuple riveted
Firebox, length	60 ins.
Firebox width	68 ins.
Firebox depth	front, 65½ ins.; back, 56½ ins.
Firebox material	Otis steel.
Firebox plates	sides, ⅜ in.; back, ⅜ in.
Firebox plates	crown, ⅜ in.; tube, ½ in.
Firebox water space	front, 4 ft.; side, 3½ ins.; back, 3½ ins.
Firebox crown stays, radial diameter	1 in.
Firebox staybolts	Ewald and Ulster Special.
Tubes, material	Charcoal iron.
Tubes, length	15 ft.
Tubes, number	237
Tubes, diameter	2 ins.
Tubes, thickness	No. 11.
Heating surface, tubes	1,833 sq. ft
Heating surface, firebox	106 sq. ft
Heating surface, total	1,939 sq. ft.
Grate, style	Rocking, 2 sections.
Grate area	28 sq. ft.
Exhaust pipe, style	Single.
Exhaust pipe, nozzle	4¾ ins., 4⅞ ins. and 5 ins.
Smokestack, inside diameter	15 ins. and 17⅛ ins.
Feed water supplied by	2 Nathan No. 9 Simplex.

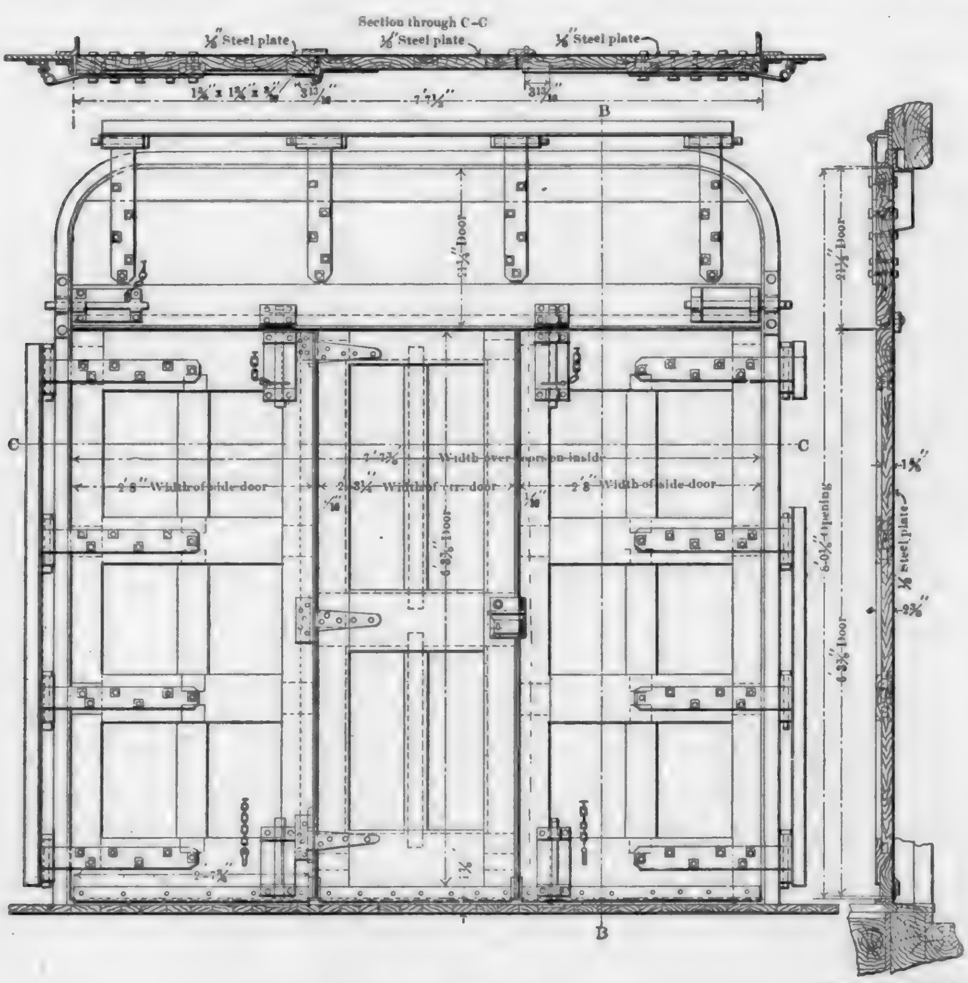
TENDER.

Weight, empty	41,600 lbs.
Frame	13 in. channels
Wheels, number	8
Wheels, diameter	33 ins.
Journals	4¼ ins. by 8 ins.
Wheel base	16 ft.
Tank capacity, water	6,000 gals.
Tank capacity, coal	7 tons.

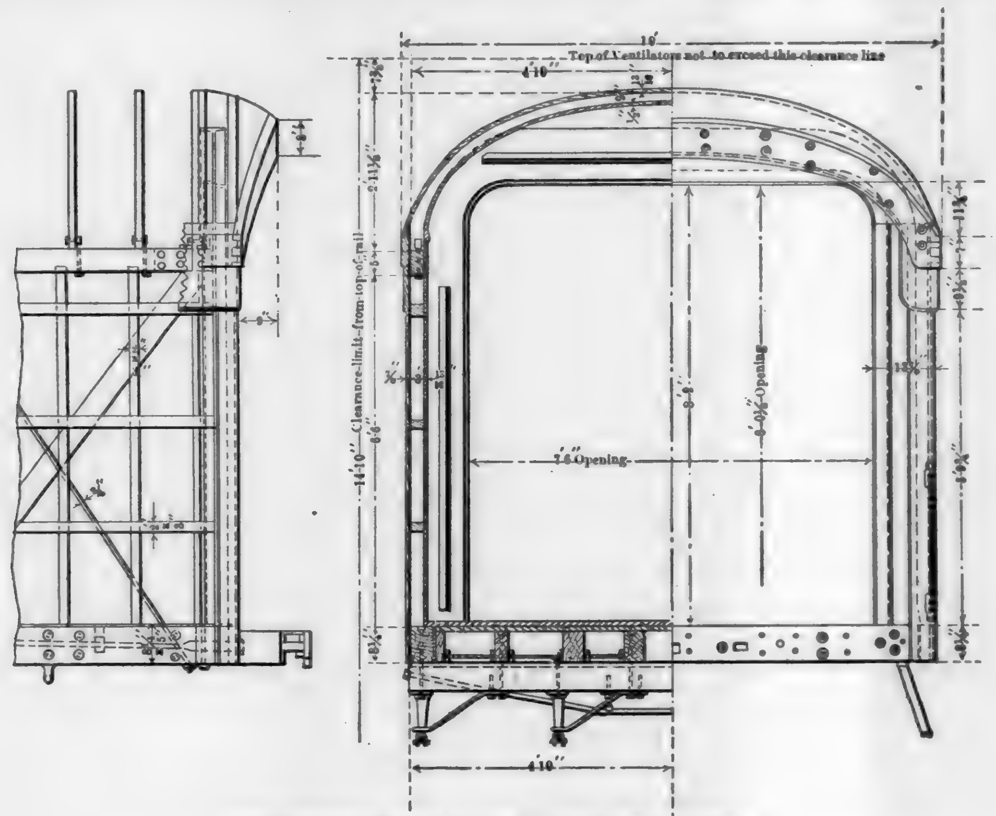
BAGGAGE CAR FOR AUTOMOBILES.

The New York Central recently built at their West Albany shops two baggage cars, to be used for transporting automobiles. The floor and side framing is similar to that of their standard baggage cars, but the roof and end framing has been changed considerably because of the necessity of providing a large opening at one end of the car, through which the automobiles may be loaded. The car is 60 ft. 10 in. long over the end sills, 10 ft. wide over the eaves, and 14 ft. 3½ in. from the rail to the top of the roof. It has two door openings on each side, one 8 ft. and the other 4 ft. 6 in. wide, and both 6 ft. 5½ in. high. The location of these doors is reversed on opposite sides. One end of the car is fitted with a standard end door, while the other end has a door opening 7 ft. 6 in. wide and 8 ft. ⅛ in. high. To use a door of this height, it was necessary to do away with the clere-story type of roof and to use a round top roof, as shown on the drawings. In addition to providing more head room, this roof is simpler and stronger than the clere-story type. In place of the deck sash, 6-in. globe ventilators are used.

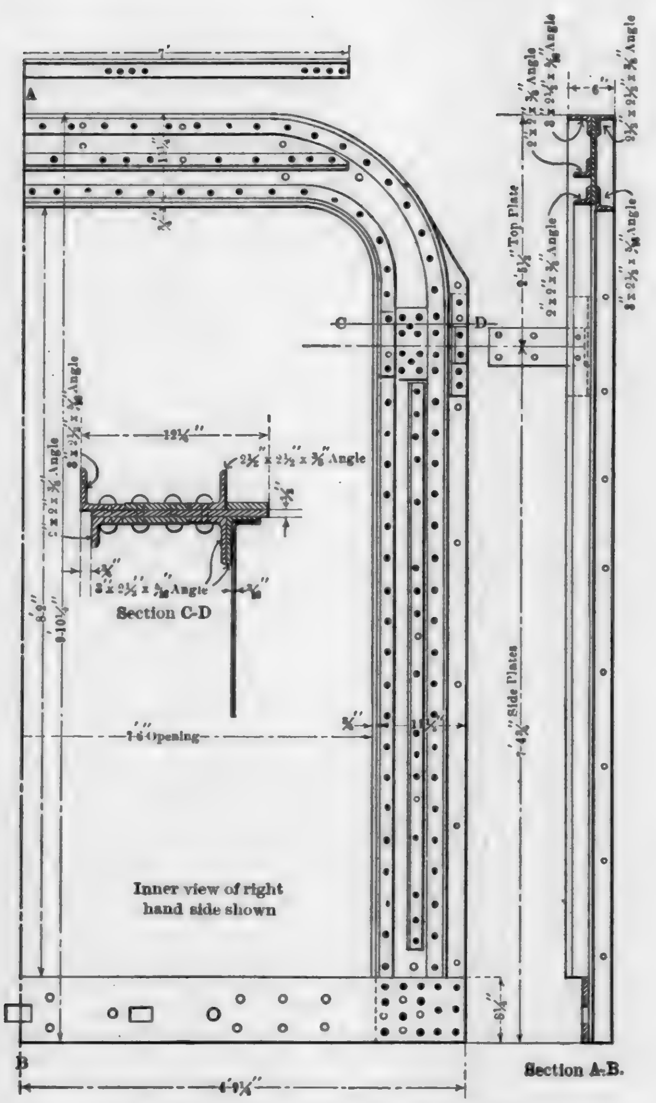
The large end door is made in four sections, as shown in the drawing, and for ordinary purposes the middle section, which is about the same size as the standard end door, may be used. Two of these sections swing to one side, one of them swings to the other side, and the upper part, which extends the full width of the opening, swings up to the roof. The hinges are so arranged that when the doors are swung back, the full size of the door opening is available. To compensate for the reduction in the strength of the end, due to the large opening, the door frame consists of a half-inch steel plate, which extends from the under-framing, up each side and across the top in the form of a flat arch. Angles are riveted to both edges of this plate, and it is otherwise stiffened, as shown in the detail drawing. A half-inch plate, 8¼ in. wide, ties the two ends together at the bottom. The roof is supported by 2 x 2 in. wood carlins, which are fastened to the side framing by means of strap bolts extending through the side plates. At intervals of 5 ft. 6 in., iron carlins are used, to which nailing blocks are fastened with ⅝ in. bolts. Four-wheel trucks are used. We are indebted to Mr. F. M. Whyte, general mechanical engineer, for information and drawings.



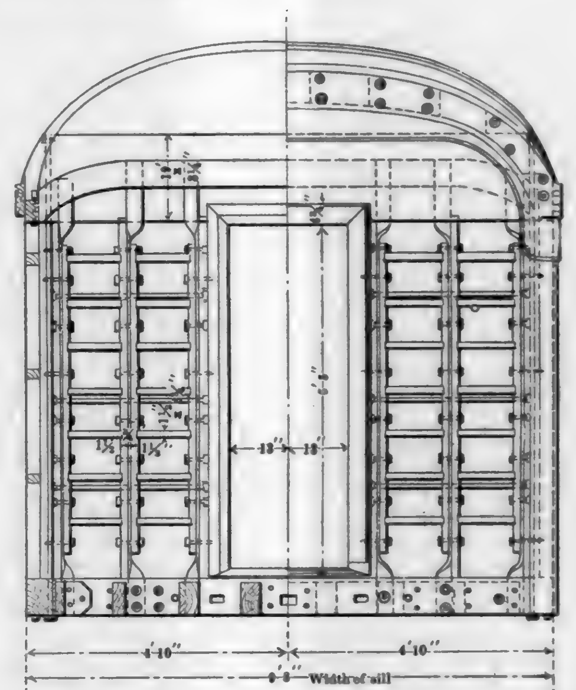
DETAILS OF LARGE END DOOR OF CAR FOR AUTOMOBILES.



CONSTRUCTION OF END HAVING LARGE DOOR OPENING.



STEEL FRAME FOR LARGE DOOR OPENING.



FRAMING OF END OF THE CAR HAVING SMALL DOOR OPENING.

SHOP OFFICIALS SHOULD KNOW THE COST OF WORK.—I know from personal experience that where the cost of work on locomotives has been promptly furnished to the master mechanic and general foreman, and also distributed so as to give the foreman of the boiler shop, the blacksmith shop, the tin shop, the carpenter shop, machine shop, erecting shop and all sub-departments their proportion of the labor and material, it has often impressed them with the high cost of their part of the work and has stimulated them to keep down expenses in their department, thereby saving large sums of money to the railroad company. The effect of such information is much lessened when it is three or four months old. It ought to be furnished within 20 days after the end of the month, so that the work done on the engine will be clear in the minds of the men who supervised it.—*Mr. M. K. Barnum, before the Western Railway Club.*

(Established 1832).

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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English locomotive people are not a little troubled with the spark problem. English locomotives, as a rule, have no device for catching or pulverizing sparks. A motive power official of a leading road recently remarked that it was perfectly easy to stop sparks throwing, but he could not at the same time make engines steam. This seems to throw some light on the effect of the free front ends upon the high efficiency of English locomotives.

A very important and noticeable feature in connection with the most recently designed machine tools is the centralization of all operating levers so that every operation of the machine can be controlled by the attendant without moving from his position. This is not only true of variable speed motor driven tools, but is also true of those having mechanical speed changes, although in several cases a considerable number of mechanical changes have been provided. With machine tools as convenient as these and made "fool proof," as most of them are, the records which are being made in some of the recently equipped railroad machine shops are not at all surprising.

An important feature of the balanced compound locomotive, which has not received the attention which its importance deserves, is the small longitudinal disturbing forces as compared with those in a single expansion locomotive. The excessive longitudinal forces in a single expansion locomotive running at a high rate of speed are undoubtedly largely responsible for the many frame and cylinder breakages of recent years, and it is quite reasonable to expect that the cost of maintenance of these parts, as well as others which are indirectly subjected to these forces, will be considerably reduced, due to the introduction of the balanced compound system. The results of Mr. Coster's investigation are worthy of careful thought and study.

On a system where a large number of types and classes of locomotives are in use it is important, in order that the tonnage rating system may be used to the best advantage, that a simple classification be adopted so that the transportation department may readily determine just what rating a particular engine should carry, even though they had never seen or had any experience with it before. A very simple and successful classification is in use on the Rock Island System, and is based on the tractive power of the engine. A detailed description of this system will be found on another page of this issue.

A large machine tool recently installed in a certain railroad shop, and costing several thousand dollars, forms a rather imposing monument to a lack of proper care in the selection of machine tools by those in charge. The tool cost about the same and weighs somewhat more than a similar tool in a nearby shop, but it can only turn out a little more than half as much work, and this is due to no fault on the part of the operator, but because of the poor design and a lack of certain improvements. A photograph, a skillfully worded specification and a sharp salesman were the arguments which caused the railroad company to invest in the tool. Something more than this is necessary.

In studying the work of a motive power official who has been remarkably successful, one feature which has undoubtedly contributed largely to his succcess is especially noticeable. If a subordinate makes a mistake, or is not getting the results expected of him, this officer, instead of finding fault, and thus discouraging the man, takes the matter up with him in a kindly but firm manner, explains the seriousness of the fault, and then makes suggestions as to how conditions may be improved, and talks the matter over with him in an intelligent and friendly spirit. While the man is made to fully realize the seriousness of his fault, he is at the same time encouraged to do better, and is given some cue as to how better results may be obtained. Continual fault finding tends to cause a man to lose his self-respect and to paralyze his energies. Directing attention to errors or weak spots and at the same time intelligently coaching the man to do better causes him to put forth his best efforts, and greatly increases his earning capacity. It has been said that the head of the motive power department is paid to criticize, but his criticism should be constructive, not destructive.

The English way of receiving a railroad supply man visiting motive power officials in the line of his business was recently described to the writer, by one who has been very successful in securing "results" in England. This method presents many good points and is worthy of consideration on this side of the water. This gentleman said "In the first place letters of introduction are necessary in England. At the outset I adopted the plan of writing to the official I wanted to see, stating that I had letters of introduction, requesting the privilege of presenting them, and asking for an appointment. This was put in diplomatic language and I also stated my purpose, putting this in a language which would show him that I would not waste a moment of his time. My subject interested these gentlemen and in every case an appointment was made. The call was invariably punctual to the appointment and the official always had all the papers and information pertaining to the subject of my interview on his table and was ready at once to proceed. It is absolutely useless in England, or on the Continent, to call upon a railway official without the formality of an appointment and the mere presentation of a card causes the porter or chief clerk to loom up as an obstruction as big as a house. He is both formidable and effective in this capacity. I have also found that the word of the English railway official is as good as their bond, in not a single case was a promise to investigate or communicate, violated or forgotten. These officials do not permit themselves to be interrupted; they are exceedingly

jealous of their time, and while the office hours are relatively short their work is intense and systematic. I found it necessary to first understand and then follow the methods of this country and have learned to regard them with favor."

THE BOILER SHOP FOR COLLEGE MEN.

Editors would be able to set forth many more good ideas if people who are in direct contact with the problems would occasionally forget to say: "Not for publication."

In vigorous sentences a correspondent discusses the need of leadership talent in the boiler shop, and deplores the tendency for young men who are looking for advancement to pass by this department. His letter ought to be printed. It shows how young men desiring opportunities want to get into the machine shop, where many of them begin and end. If some of them would enter the boiler shop they could fit themselves to earn from $125 to $200 per month in as short a time as it can be done anywhere, providing they are qualified to direct the work of other men. A few bright young men would attract attention to this department and assist in securing a better grade of men who are looking for advancement. Boiler work is hard, noisy and disagreeable. A good physique is required, but what becomes of the muscle developed on the "gridiron?" Boiler work would keep this muscle in good condition, and if a young man is successful in the boiler shop he has made an excellent start in his career.

It is evident that the boiler shop is to-day in need of improvement and of men. Here is where good men will be able to show their value quickly and for this reason this shop ought to be attractive to the young men entering railroad work from the colleges. It offers a better opportunity at present than any other shop department.

GRAPHICAL RECORDS.

The heads of at least two of the railroad motive power departments in America carry with them notebooks, in which a large number of records pertaining to their departments, and extending over a considerable period of time, are plotted graphically. If they are called into the general manager's office for consultation, or are accompanying their superior officers on a trip, they can, at a moment's notice, supply detail information concerning almost any important feature connected with their department. They can also readily see just how various items are affecting the operation, and can readily follow the work of their subordinate officers and locate weak spots. A few weeks ago, while in the office of one of these men, a shop superintendent was asked for certain information concerning the output of the shop and the effect of certain improvements which had been introduced. He took from his pocket one of these notebooks containing a number of diagrams, and showed clearly and forcibly inside of three or four minutes just what results were being obtained. To have conveyed the same information by the use of figures alone would have consumed a considerable longer time, and it is very doubtful if, even under favorable circumstances, they would have conveyed half as clear or forcible an idea of what had been accomplished. There is not much satisfaction in wading through a mass of figures or statistics, but if they are plotted out graphically their relative importance can be grasped almost instantly. On another page of this issue is an article concerning the practical use of these diagrams. The expense of maintaining such records is comparatively slight, and when it is considered that they save much of the motive power official's time and give him a very clear and forcible idea of what his department is doing, and thus add very greatly to his efficiency, it is surprising that they are not more generally used.

The article by Mr. Larsen shows several applications of this system to mechanical department records and suggests a number of items which can be treated in this way with satisfactory results.

COMPARATIVE MAGNITUDE OF LONGITUDINAL DISTURBING FORCES IN A COLE BALANCED COMPOUND AND A SINGLE EXPANSION EXPRESS LOCOMOTIVE.

BY EDWARD L. COSTER, ASSOC. AM. SOC. M. E.

Since little definite information has yet been published upon the subject of the comparative magnitude of the longitudinal disturbing forces in the four-cylinder balanced, and the ordinary two-crank locomotive, I beg to submit the following analysis of the relative horizontal inertia effects in a recent 4—4—2 type, Cole balanced compound locomotive, and a very carefully designed single-expansion locomotive of the same type, and of approximately equal power; the particulars of both engines having been kindly supplied me by the builders.

TABLE I. PARTICULARS OF LOCOMOTIVES.

Class of locomotive	Cole Bal. Compound.	Single Expansion.
Diameter of H. P. cylinders	16 in.	22 in.
Diameter of L. P. cylinders	27 in.	......
Piston stroke	26 in.	26 in.
Driving wheel diameter	80 in.	80 in.
Working steam pressure	205 lb. per sq. in.	205 lb. per sq. in.
Weight of locomotive, empty	178,600 lb.	163,100 lb.
Weight of locomotive in working order	200,500 lb.	183,100 lb.
Adhesive weight, in working order	117,200 lb.	118,200 lb.
Maximum tractive force, operating compound	23,300 lb.	With M. E. P. = 0.85 boiler pressure.
Maximum tractive force, with direct admission to L. P. cylinders	27,600 lb.	27,409 lb.
Weight of H. P. piston, piston rod and key, cross-head and pin, complete	581 lb.	683 lb.
Weight of L. P. piston, piston rod and key, cross-head and pin, complete	598 lb.	......
Weight of H. P. connecting rod, front end	146 lb.	255 lb.
Weight of H. P. connecting rod, back end	354 lb.	403.5 lb.
Weight of H. P. connecting rod, total	500 lb.	658.5 lb.
Weight of L. P. connecting rod, front end	189 lb.	......
Weight of L. P. connecting rod, back end	399 lb.	......
Weight of L. P. connecting rod, total	588 lb.	......
Length of H. P. connecting rod	101 in. = 8.417 ft.	135⅞ in. = 11.323 ft.
Length of L. P. connecting rod	130 in. = 10.833 ft.	......
Distance of center of gravity of H. P. connecting rod from crank-pin center	29.492 in. = 2.458 ft.	52.617 in. = 4.385 ft.
Distance of center of gravity of L. P. connecting rod from crank-pin center	41.786 in. = 3.482 ft.	......
Crank radius	13 in. = 1.08 ft.	13 in. = 1.08 ft.

Disregarding the effects of steam action, to determine the forces exerted on the main crank-pin by the inertia of the reciprocating parts and the connecting rod at the ends of the stroke:

Let G = weight of reciprocating parts in pounds.
G' = weight of connecting rod in pounds.
l = length of connecting rod in feet.
d = distance of center of gravity of connecting rod from crank-pin center in feet.
r = crank radius in feet.
s = piston stroke in inches.
P_F = inertia of reciprocating parts at front dead center in pounds.
P_B = inertia of reciprocating parts at back dead center in pounds.
P'_F = horizontal inertia of connecting rod at front dead center in pounds.
P'_B = horizontal inertia of connecting rod at back dead center in pounds.
C = centrifugal force of connecting rod at both dead centers in pounds.

Then, as demonstrated in Henderson's "Locomotive Operation" (pp. 26-31 and 39-40), for a translational velocity in miles per hour equal to the driving-wheel diameter in inches, we have:

$$P_F = 1.6\, G\, s \left[1 + \frac{r}{l}\right]$$

$$P_B = 1.6\ G\ s\left[1-\frac{r}{l}\right]$$

$$P'_F - C = 1.6\ G'\ s\left[1+\frac{2dr-rl}{l^2}\right]$$

$$P'_B + C = 1.6\ G'\ s\left[1-\frac{2dr-rl}{l^2}\right]$$

Introducing into these equations the values given in the above table for the locomotives under consideration, then at 80 m.p.h., the stresses on the main crank-pins at the dead points, due to the inertia of the reciprocating parts and the connecting rod, are as follows:

COLE BALANCED COMPOUND LOCOMOTIVE.

For the H.P. reciprocating parts

$$P_F = 1.6\times581\times26\left[1+\frac{1.08}{8.417}\right] = 24{,}169.6\times1.12831 = 27{,}270.8 \text{ lb.}$$

$$P_B = 24{,}169.6\ [1-0.12831] = 24{,}169.6\times0.87169 = 21{,}068.4 \text{ lb.}$$

For the H.P. connecting rod

$$P'_F - C = 1.6\times500\times26\left[1+\frac{2\times2.458\times1.08-1.08\times8.417}{8.417^2}\right]$$

$$= 20{,}800\left[1+\frac{-3.78108}{70.846}\right]$$

$$= 20{,}800\ [1+(-0.05337)] = 20{,}800\times0.94663 = 19{,}689.9 \text{ lb.}$$

$$P'_B + C = 20{,}800\ [1-(-0.05337)] = 20{,}800\times1.05337 = 21{,}910.1 \text{ lb.}$$

Hence the net horizontal inertia forces on the H.P. crank-pin are:

At the front dead center,

$$P_F + (P'_F - C) = 27{,}270.8 + 19{,}689.9 = 46{,}960.7 \text{ lb.}$$

At the back dead center,

$$P_B + P'_B + C = 21{,}068.4 + 21{,}910.1 = 42{,}978.5 \text{ lb.}$$

For the L.P. reciprocating parts

$$P_F = 1.6\times598\times26\left[1+\frac{1.08}{10.833}\right] = 24{,}876.8\times1.09969 = 27{,}356.8 \text{ lb.}$$

$$P_B = 24{,}876.8\ [1-0.09969] = 24{,}876.8\times0.90031 = 22{,}396.8 \text{ lb.}$$

For the L.P. connecting rod

$$P'_F - C = 1.6\times588\times26\left[1+\frac{2\times3.482\times1.08-1.08\times10.833}{10.833^2}\right]$$

$$= 24{,}460.8\left[1+\frac{-4.17852}{117.354}\right]$$

$$= 24{,}460.8\ [1+(-0.03561)] = 24{,}460.8\times0.96439 = 23{,}589.7 \text{ lb}$$

$$P'_B + C = 24{,}460.8\ [1-(-0.03561)] = 24{,}460.8\times1.03561 = 25{,}331.8 \text{ lb}$$

Hence the net horizontal inertia forces on the L.P. crank-pin are:

At the front dead center,

$$P_F + (P'_F - C) = 27{,}356.8 + 23{,}589.7 = 50{,}946.5 \text{ lb.}$$

At the back dead center,

$$P_B + P'_B + C = 22{,}396.8 + 25{,}331.8 = 47{,}728.6 \text{ lb.}$$

Consequently, the effect upon the locomotive as a whole is as follows:

With the H.P. crank at the front center and the L.P crank at the back center, the resulting longitudinal disturbing force is

47,728.6—46,960.7=767.9 lb., acting backward.

With the H.P. crank at the back center and the L.P. crank at the front center, the unbalanced force is

50,946.5—42,978.5=7,968 lb., acting forward.

The total variation per semi-revolution being,

767.9+7.968=8,735.9 lb.

SINGLE-EXPANSION LOCOMOTIVE.

For the reciprocating parts

$$P_F = 1.6\times683\times26\left[1+\frac{1.08}{11.323}\right] = 28{,}412.8\times1.09538 = 31{,}122.8 \text{ lb.}$$

$$P_B = 28{,}412.8\ [1-0.09538] = 28{,}412.8\times0.90462 = 25{,}702.8 \text{ lb.}$$

For the connecting rod

$$P'_F - C = 1.6\times658.5\times26\left[1+\frac{2\times4.385\times1.08-1.08\times11.323}{11.323^2}\right]$$

$$= 27{,}393.6\left[1+\frac{-2.75724}{128.21}\right]$$

$$= 27{,}393.6\ [1+(-0.0215)] = 27{,}393.6\times0.9785 = 26{,}804.6 \text{ lb.}$$

$$P'_B + C = 27{,}393.6\ [1-(-0.0215)] = 27{,}393.6\times1.0215 = 27{,}982.6 \text{ lb.}$$

Hence the net horizontal inertia forces on the main crank-pin, or the longitudinal disturbing effects upon the locomotive as a whole are:

At the front dead center,

$P_F + (P'_F - C) = 31{,}122.8 + 26{,}804.6 = 57{,}927.4$ lb., acting forward.

At the back dead center,

$P_B + P'_B + C = 25{,}702.8 + 27{,}982.6 = 53{,}685.4$ lb., acting backward.

The total variation per semi-revolution being,

57,927.4+53,685.4=111,612.8 lb.

The foregoing results are summarized in the following table:

TABLE II. INERTIA OF RECIPROCATING PARTS AND CONNECTING ROD AT 80 M.P.H., OR 336 R.P.M.

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The machinery of this engine represents a high degree of lightness and refinement of design, hence it is evident that the great comparative reduction of the longitudinal inertia forces obtained in the four-cylinder balanced locomotive, as given in the last column of the table, constitutes an important advantage of this type of engine for heavy fast passenger service.

The two new Cunard liners which are being built in Scotland will each be equipped with four steam turbines, each designed for an indicated horse-power of 18,000.

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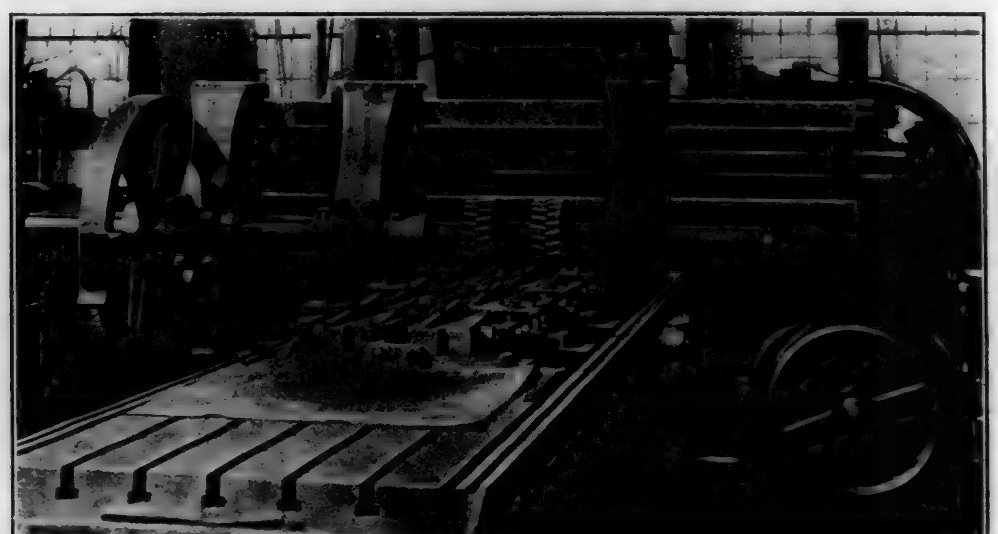
FIG. 2.—MILLING DRIVING BOX FACE OF SHOES AND WEDGES.

FIG. 3.—MILLING OUTSIDES AND TOPS OF THE FLANGES OF SHOES AND WEDGES.



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PRODUCTION IMPROVEMENTS.

Milling Castings at the Angus Shops.

On page 406 of our November journal we described the milling of cast iron and cast steel driving boxes at the Angus shops of the Canadian Pacific Railway. In addition to milling the driving boxes they are having considerable success in milling other castings, including engine truck boxes, shoes and wedges and cast steel crosshead shoes. To handle this work to advantage, it is, of course, advisable to run the different castings through in fairly large quantities, so that as little time as possible will be lost in changing the jigs and tools. It is also advisable to have as many rows of castings as the width and the power of the machine will permit, as the cutting time is the same for two or more rows as for one. While the cost of the milling cutters, which are of high speed steel, is rather high yet when we consider that often several faces are finished by one tool at the same time, and that the castings are roughed and finished with one cut, it can readily be seen that the cost of the cutters may be saved in a short time. The milling cutters are made at the Angus shops and are easily kept sharp and in good condition, a Landis grinding machine being provided for this purpose. The machine upon which the work is done is a 48 in. Bement-Miles & Company motor driven horizontal miller.

ENGINE TRUCK BOXES.

The engine truck boxes are handled in practically the same manner as the driving boxes. The sides are first milled with an inserted tooth cutter 8 ins. in diameter and 30 ins. long; a long double knee or angle plate is then placed on the table of the machine and a row of boxes is bolted on each side of this plate the full length of the table; the two sets of adjustable, plate cutters, which are 12 ins. in diameter (the same as used for the driving boxes and shown in Fig. 2, page 406), are then placed on the arbor and adjusted for the proper width of the engine truck pedestal jaws, and the boxes are finished in the same manner as the driving boxes.

SHOES AND WEDGES.

In milling the shoes and wedges the jig shown in Fig. 1 is used. At the present time

$$P_B = 1.6\ G\ s \left[1 - \frac{r}{l}\right]$$

$$P'_F - C = 1.6\ G'\ s \left[1 + \frac{2dr - rl}{l^2}\right]$$

$$P'_B + C = 1.6\ G'\ s \left[1 - \frac{2dr - rl}{l^2}\right]$$

Introducing into these equations the values given in the above table for the locomotives under consideration, then at 80 m.p.h., the stresses on the main crank-pins at the dead points, due to the inertia of the reciprocating parts and the connecting rod, are as follows:

COLE BALANCED COMPOUND LOCOMOTIVE.

For the H.P. reciprocating parts

$$P_F = 1.6 \times 581 \times 26 \left[1 + \frac{1.08}{8.417}\right] = 24{,}169.6 \times 1.12831 = 27{,}270.8 \text{ lb.}$$

$$P_B = 24{,}169.6\ [1 - 0.12831] = 24{,}169.6 \times 0.87169 = 21{,}068.4 \text{ lb.}$$

For the H.P. connecting rod

$$P'_F - C = 1.6 \times 500 \times 26 \left[1 + \frac{2 \times 2.458 \times 1.08 - 1.08 \times 8.417}{8.417^2}\right]$$

$$= 20{,}800 \left[1 + \frac{-3.78108}{70.846}\right]$$

$$= 20{,}800\ [1 + (-0.05337)] = 20{,}800 \times 0.94663 = 19{,}689.9 \text{ lb.}$$

$$P'_B + C = 20{,}800\ [1 - (-0.05337)] = 20{,}800 \times 1.05337 = 21{,}910.1 \text{ lb.}$$

Hence the net horizontal inertia forces on the H.P. crank-pin are:

At the front dead center,

$$P_F + (P'_F - C) = 27{,}270.8 + 19{,}689.9 = 46{,}960.7 \text{ lb.}$$

At the back dead center,

$$P_B + P'_B + C = 21{,}068.4 + 21{,}910.1 = 42{,}978.5 \text{ lb.}$$

For the L.P. reciprocating parts

$$P_F = 1.6 \times 598 \times 26 \left[1 + \frac{1.08}{10.833}\right] = 24{,}876.8 \times 1.09969 = 27{,}356.8 \text{ lb.}$$

$$P_B = 24{,}876.8\ [1 - 0.09969] = 24{,}876.8 \times 0.90031 = 22{,}396.8 \text{ lb.}$$

For the L.P. connecting rod

$$P'_F - C = 1.6 \times 588 \times 26 \left[1 + \frac{2 \times 3.482 \times 1.08 - 1.08 \times 10.833}{10.833^2}\right]$$

$$= 24{,}460.8 \left[1 + \frac{-4.17852}{117.354}\right]$$

$$= 24{,}460.8\ [1 + (-0.03561)] = 24{,}460.8 \times 0.96439 = 23{,}589.7 \text{ lb}$$

$$P'_B + C = 24{,}460.8\ [1 - (-0.03561)] = 24{,}460.8 \times 1.03561 = 25{,}331.8 \text{ lb}$$

Hence the net horizontal inertia forces on the L.P. crank-pin are:
At the front dead center,

$$P_F + (P'_F - C) = 27{,}356.8 + 23{,}589.7 = 50{,}946.5 \text{ lb.}$$

At the back dead center,

$$P_B + P'_B + C = 22{,}396.8 + 25{,}331.8 = 47{,}728.6 \text{ lb.}$$

Consequently, the effect upon the locomotive as a whole is as follows:

With the H.P. crank at the front center and the L.P crank at the back center, the resulting longitudinal disturbing force is

47,728.6 — 46,960.7 = 767.9 lb., acting backward.

With the H.P. crank at the back center and the L.P. crank at the front center, the unbalanced force is

50,946.5 — 42,978.5 = 7,968 lb., acting forward.

The total variation per semi-revolution being,

767.9 + 7,968 = 8,735.9 lb.

SINGLE-EXPANSION LOCOMOTIVE.

For the reciprocating parts

$$P_F = 1.6 \times 683 \times 26 \left[1 + \frac{1.08}{11.323}\right] = 28{,}412.8 \times 1.09538 = 31{,}122.8 \text{ lb.}$$

$$P_B = 28{,}412.8\ [1 - 0.09538] = 28{,}412.8 \times 0.90462 = 25{,}702.8 \text{ lb.}$$

For the connecting rod

$$P'_F - C = 1.6 \times 658.5 \times 26 \left[1 + \frac{2 \times 4.385 \times 1.08 - 1.08 \times 11.323}{11.323^2}\right]$$

$$= 27{,}393.6 \left[1 + \frac{-2.75724}{128.21}\right]$$

$$= 27{,}393.6\ [1 + (-0.0215)] = 27{,}393.6 \times 0.9785 = 26{,}804.6 \text{ lb.}$$

$$P'_B + C = 27{,}393.6\ [1 - (-0.0215)] = 27{,}393.6 \times 1.0215 = 27{,}982.6 \text{ lb.}$$

Hence the net horizontal inertia forces on the main crank-pin, or the longitudinal disturbing effects upon the locomotive as a whole are:

At the front dead center,

$P_F + (P'_F - C) = 31{,}122.8 + 26{,}804.6 = 57{,}927.4$ lb., acting forward.

At the back dead center,

$P_B + P'_B + C = 25{,}702.8 + 27{,}982.6 = 53{,}685.4$ lb., acting backward.

The total variation per semi-revolution being,

57,927.4 + 53,685.4 = 111,612.8 lb.

The foregoing results are summarized in the following table:

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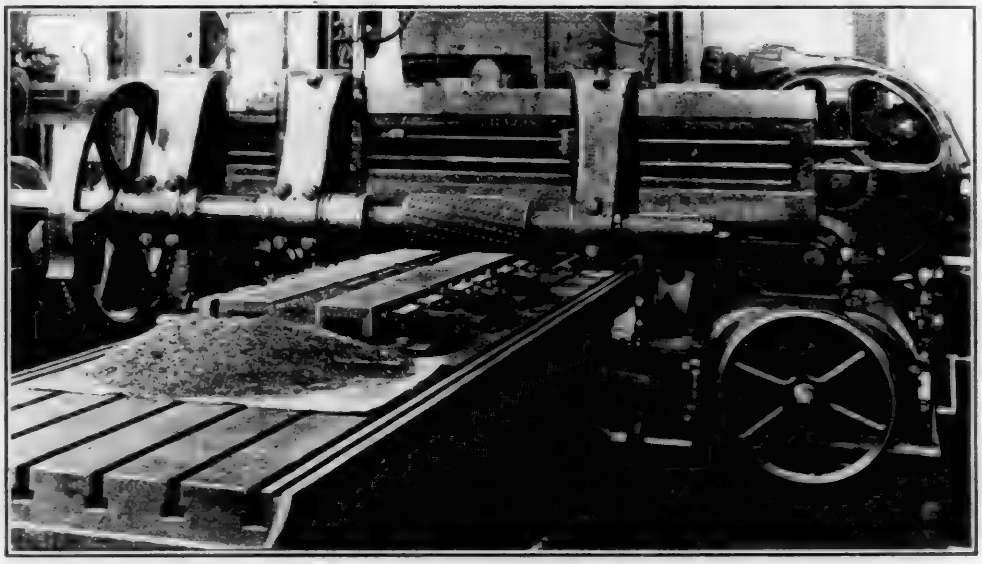

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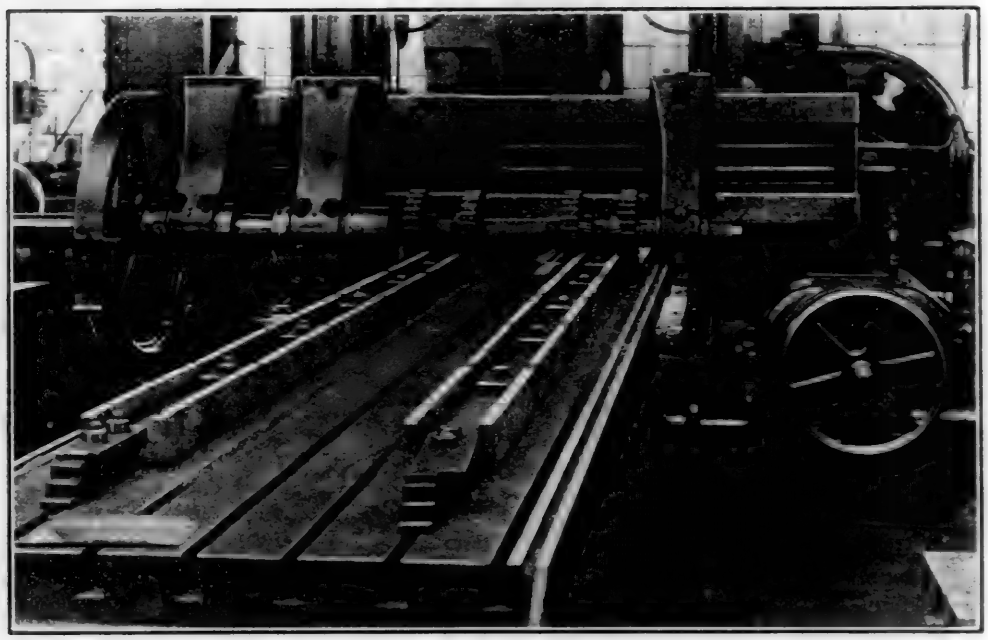

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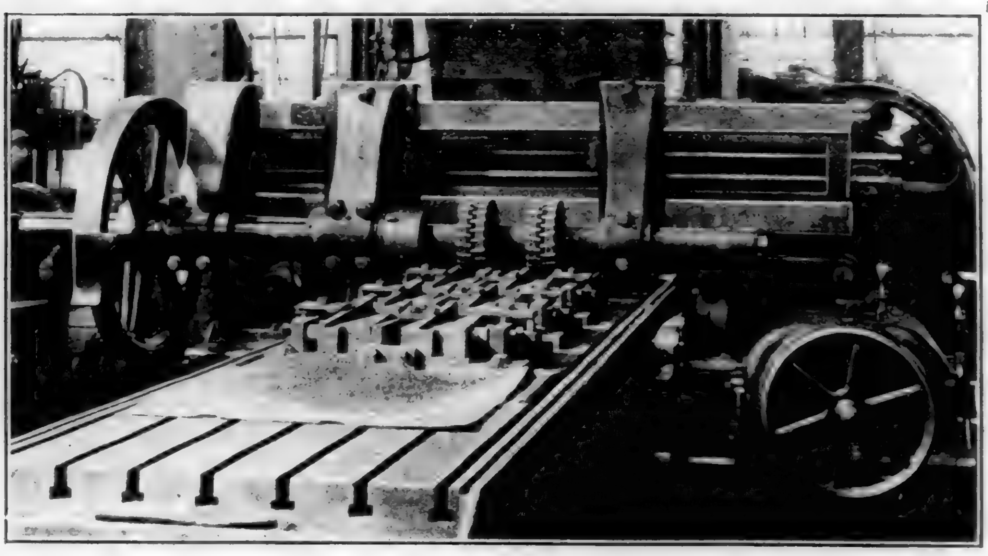

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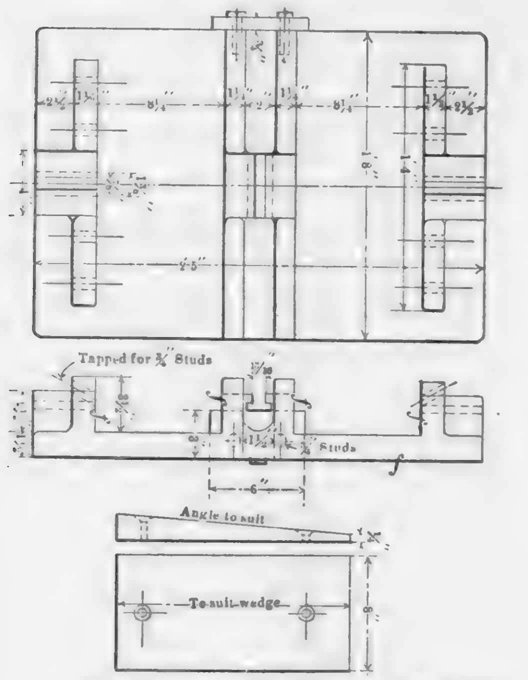


FIG. 1.—JIG USED FOR MILLING SHOES AND WEDGES AND CROSS-HEAD SHOES.

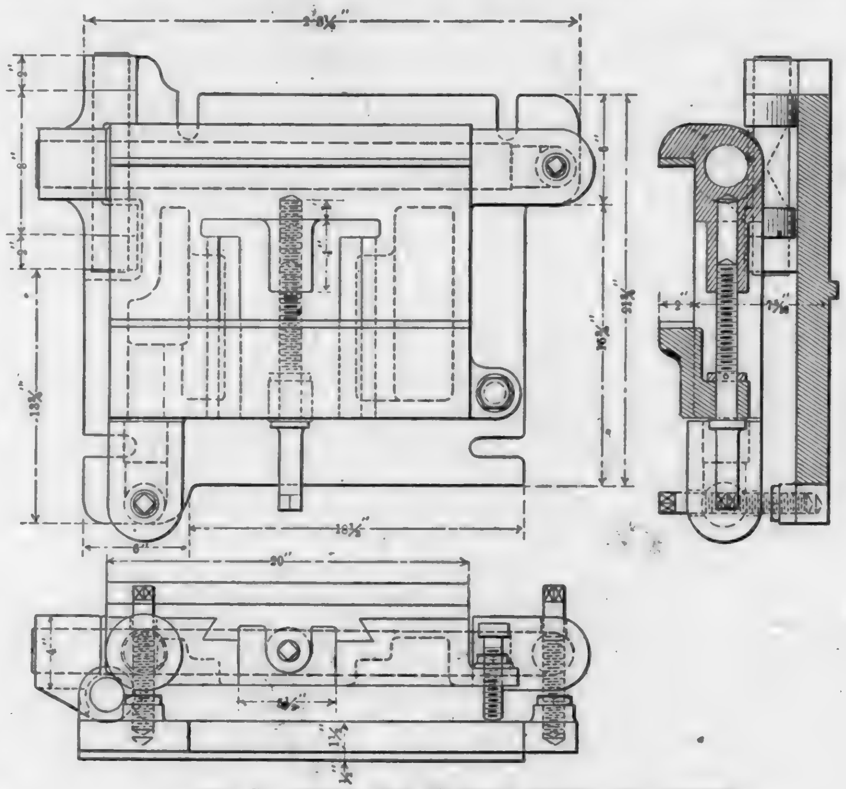


FIG. 5.—CHUCK FOR PLANING SHOES AND WEDGES.

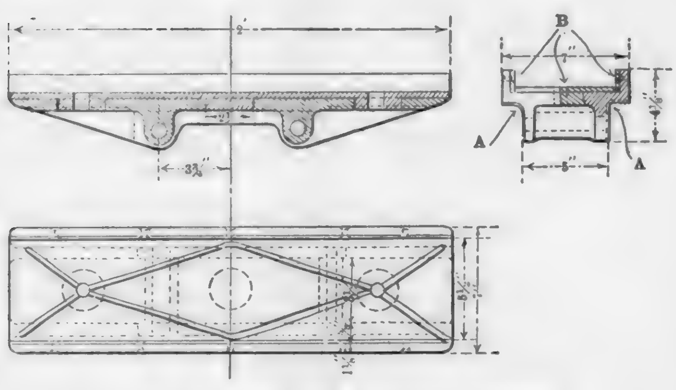


FIG. 6.—CAST STEEL CROSS-HEAD SHOES.

The length of time which the cutters, used in these three operations, will run between grindings may be of interest. The inserted tooth cutter used in the first operation will mill at least 250 large shoes or wedges for 4½-in. frames. The large cutters used in the second operation will mill 100 shoes or wedges, by reversing the cutters so as to use both sides; the small cutters are good for more than this. The cutters used in the third operation will mill 100 shoes or wedges. This means that in any of the three operations a man will run his machine for a least one full day and more without having to touch the cutters, and that in any case they will not need to be sent to the grinder until at least two full days work has been done with each of them. These figures are conservative and under these conditions the cutters will at all times give a high class finish. It must be understood that these figures were obtained for castings which had not been put through the tumbler and had only a little brushing with a wire brush, so that they were comparatively rough and sandy, especially in the corners.

The shoes and wedges are now ready to be fitted to the frames of the engine and are marked off for final adjustment, and are then taken to a crank planer where they are planed and the corners rounded. In this connection a special chuck, shown in Fig. 5 is used. This chuck, as may be seen, is adjustable in all directions and was designed by Mr. H. H. Vaughan and made by Foote, Burt & Company.

CROSSHEAD SHOES

The crosshead shoes, which are of cast steel and are shown in detail in Fig. 6, are finished in three operations, which leaves them ready to be babbitted or lined with brass liners and to be fitted to the crosshead body for drilling and for the ends to be cut off to the proper length. The tops and outsides of the flanges of these shoes are finished at one operation by means of gang cutters as shown in Fig. 7. The photograph shows only one row of shoes being milled, but it is the intention to mill two rows of six each at one time as a considerable saving may thus be effected. These shoes may be set up very quickly as each shoe has three cored holes, and it is only necessary to slip the shoes down over short T bolts which are placed in the table slots and to carefully set each shoe the same distance from the edge of the table and parallel with it. The large cutters are of the inserted plate type 12 ins. in diameter and the small ones are solid, 6 ins. in diameter. They are operated at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute. The photograph shows quite plainly the rubber hose with the T at its end just above the cutter. This hose is connected with a reservoir which furnishes the compound for use when cast steel is

being milled. For the second operation the shoes are turned over and bolted down to the table, and the fit for the cross head body is milled (See A Fig. 6). The cutters used for this operation are of the inserted plate type, 13 ins. in diameter and are operated at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute. For the third operation the same jig which is used for the shoes and wedges and which is shown in detail in Fig. 1 is used. The three surfaces marked B on Fig. 6 are finished in this operation. Inserted plate cutters 13 ins. in diameter and so arranged that they can be adjusted for width are used and operate at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute.

We are indebted for information and drawings to Mr. H. H. Vaughan, superintendent of motive power, Mr. H. Osborne, superintendent of shops and Mr. Gustave Giroux, piece work inspector.

FIG. 7.—FINISHING THE TOPS AND OUTSIDES OF THE FLANGES OF CAST STEEL CROSS-HEAD SHOES.

MECHANICAL DEPARTMENT RECORDS—THE GRAPHIC SYSTEM.

By L. A. Larsen.*

To insure satisfactory results in the intricate and manifold interests of railroading, particularly in the mechanical department—to show low costs and high service—an organization must be maintained which shall control the details. These being determined, the results are bound to follow. Among the essential elements of such an organization may be mentioned:

1. Systematic instructions.
   (a) Covering all important matters.
   (b) Complete, concise, and revised as demanded by changing conditions.
2. Assurance that these instructions are being observed, which requires
   (a) Familiarity on part of all concerned with them.
   (b) Regular reports, showing returns.
3. Records, showing plainly the results.

This article does not discuss either the first or second, which deserve separate attention, but treats only of records in the mechanical department. The elements of a good record are (1) accuracy, (2) permanence, (3) simplicity, (4) comparison. There are, in general, three methods of recording results: (1) as contained in the original reports, (2) in books and statements, (3) the graphic system. Each has something to commend itself. The first two certainly bear the stamp of long usage, but this alone cannot be accepted as final in their defense. It is not our purpose to point out the defects of these methods, though we might do so, but to indicate the merits of the third, or graphic system. It has been only in recent years, since the rise of the technician, that the value of the graphic method has been recognized, and its field of usefulness has been but meagerly covered.

The graphic record, or diagram, is of varying sizes and styles, limited only by the varying demands. The most commonly used diagram is made of smooth, heavy white paper, 19 x 24 ins. in size, ruled at right angles in green or orange (as being best for the eye). The two general varieties are termed, respectively, the daily, one-year diagram, and the monthly, ten-year diagram. As these terms indicate, the first is used to record daily occurrences for a period of one year, the second to record monthly occurrences, expenses, etc., for a period of ten years. Reference to the illustrations will more fully explain them. Fig. 1 is a fac-simile of a part of the daily, one-year diagram. Each perpendicular column, 1-24 in. in width, represents one day, and the record shown covers a month of 31 days. The diagram has 366 of these columns, each month being distinctly shown by a heavy line, each five days also being shown by lines heavier than those distinguishing days, but not so heavy as those separating months. In like manner, the horizontal heavy lines separate spaces of five and twenty-five. These lines do not usually indicate periods of time, but are spaced for facility of calculation, each space being denominated as representing a certain number of cents, dollars, delays, etc., as may be considered most convenient.

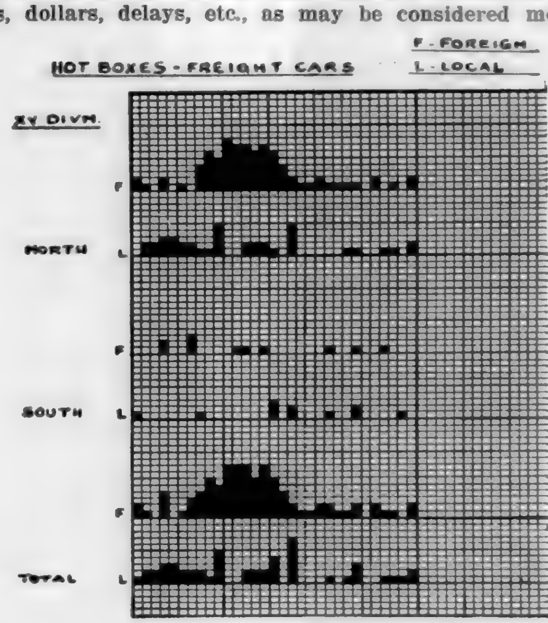
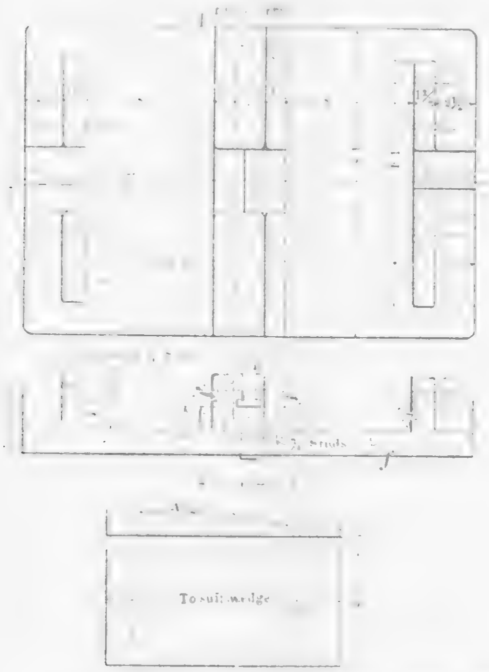


FIG. 1.

Fig. 3 is a fac-simile of a part of the monthly, ten-year diagram, and represents a record for two years. The lightest perpendicular lines separate periods of one month, those slightly heavier periods of six months, while the heaviest distinguish periods of twelve months. The horizontal lines in this diagram, as in Fig. 1, are flexible in their significance, and for convenience heavier lines distinguish certain spaces. The entries are made by using India inks (black, when but one color is needed), or a 6 H drafting pencil. The latter is more convenient, but the former is more nearly permanent.

* Mechanical Department, N. P. Ry.

only three of these jigs have been constructed, and, thus only six shoes are milled at one time. The driving box face is first milled as shown in Fig. 2. The cutter is of the inserted tooth type, 8 ins. in diameter and 18 ins. long, and operates at 12½ r.p.m. with a table feed of 2¾ ins. per min. After the first operation the jigs are removed from the table and two rows of shoes or wedges of six each are placed upon parallel strips and are securely held in place by the clamps and T bolts, as shown in Fig. 3. The outsides and the tops of the flanges are milled by the gang cutters. The large cutters are of the inserted-plate type, 13 ins. in diameter, while the small cutters are solid and 6 ins. in diameter. They operate at a speed of 12½ r.p.m., and a table feed of 15-16 in. per minute. For the third and last operation (Fig. 4) the jigs are again replaced upon the table, and the three inside surfaces of the shoe are finished by means of the double inserted plate cutters which are 12 ins. in diameter and are adjustable for width. These cutters operate at a speed of 12 r.p.m. with a table feed of 1⅜ ins. per minute. The photographs shown in Figs. 2 and 4 show clearly how the jig illustrated in Fig. 1 is used. The dummy wedge shown in Fig. 1 is fastened in the jig in order to mill the wedge to the proper angle.



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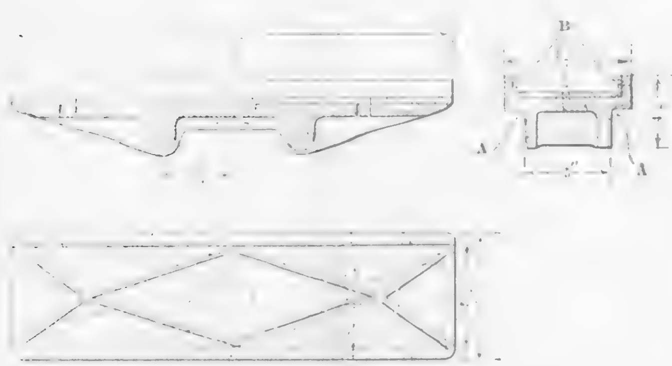


FIG. 6.—CAST STEEL CROSS-HEAD SHOES.

The length of time which the cutters, used in these three operations, will run between grindings may be of interest. The inserted tooth cutter used in the first operation will mill at least 250 large shoes or wedges for 4½-in. frames. The large cutters used in the second operation will mill 100 shoes or wedges, by reversing the cutters so as to use both sides; the small cutters are good for more than this. The cutters used in the third operation will mill 100 shoes or wedges. This means that in any of the three operations a man will run his machine for a least one full day and more without having to touch the cutters, and that in any case they will not need to be sent to the grinder until at least two full days work has been done with each of them. These figures are conservative and under these conditions the cutters will at all times give a high class finish. It must be understood that these figures were obtained for castings which had not been put through the tumbler and had only a little brushing with a wire brush, so that they were comparatively rough and sandy, especially in the corners.

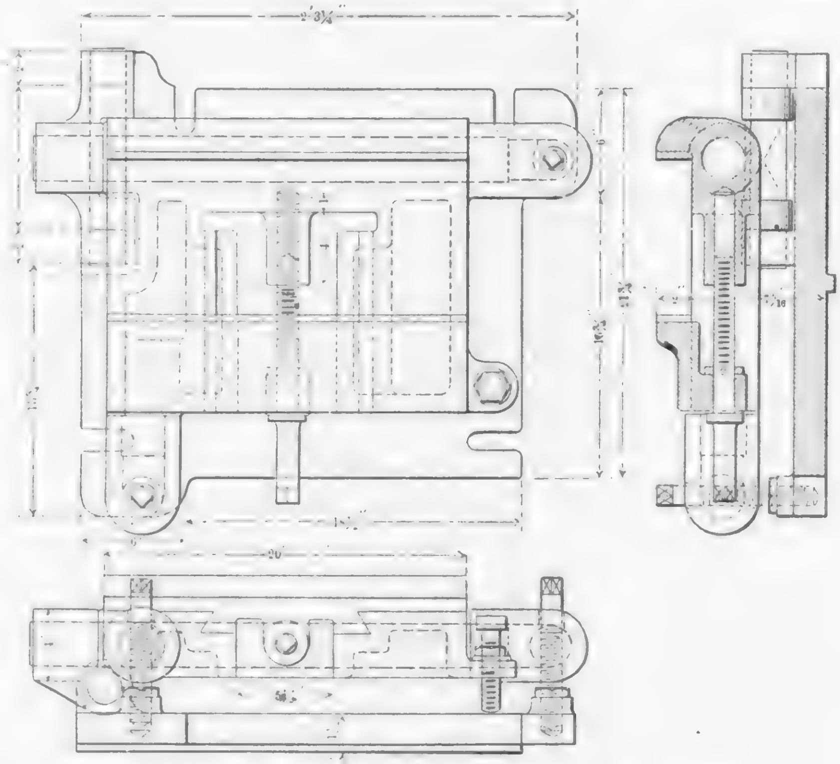


FIG. 5.—CHUCK FOR PLANING SHOES AND WEDGES.

The shoes and wedges are now ready to be fitted to the frames of the engine and are marked off for final adjustment, and are then taken to a crank planer where they are planed and the corners rounded. In this connection a special chuck, shown in Fig. 5 is used. This chuck, as may be seen, is adjustable in all directions and was designed by Mr. H. H. Vaughan and made by Foote, Burt & Company.

CROSSHEAD SHOES

The crosshead shoes, which are of cast steel and are shown in detail in Fig. 6, are finished in three operations, which leaves them ready to be babbitted or lined with brass liners and to be fitted to the crosshead body for drilling and for the ends to be cut off to the proper length. The tops and outsides of the flanges of these shoes are finished at one operation by means of gang cutters as shown in Fig. 7. The photograph shows only one row of shoes being milled, but it is the intention to mill two rows of six each at one time as a considerable saving may thus be effected. These shoes may be set up very quickly as each shoe has three cored holes, and it is only necessary to slip the shoes down over short T bolts which are placed in the table slots and to carefully set each shoe the same distance from the edge of the table and parallel with it. The large cutters are of the inserted plate type 12 ins. in diameter and the small ones are solid, 6 ins. in diameter. They are operated at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute. The photograph shows quite plainly the rubber hose with the T at its end just above the cutter. This hose is connected with a reservoir which furnishes the compound for use when cast steel is

being milled. For the second operation the shoes are turned over and bolted down to the table, and the fit for the cross head body is milled (See A Fig. 6). The cutters used for this operation are of the inserted plate type, 13 ins. in diameter and are operated at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute. For the third operation the same jig which is used for the shoes and wedges and which is shown in detail in Fig. 1 is used. The three surfaces marked B on Fig. 6 are finished in this operation. Inserted plate cutters 13 ins. in diameter and so arranged that they can be adjusted for width are used and operate at a speed of 16 r.p.m. with a table feed of 1¼ ins. per minute.

We are indebted for information and drawings to Mr. H. H. Vaughan, superintendent of motive power, Mr. H. Osborne, superintendent of shops and Mr. Gustave Giroux, piece work inspector.

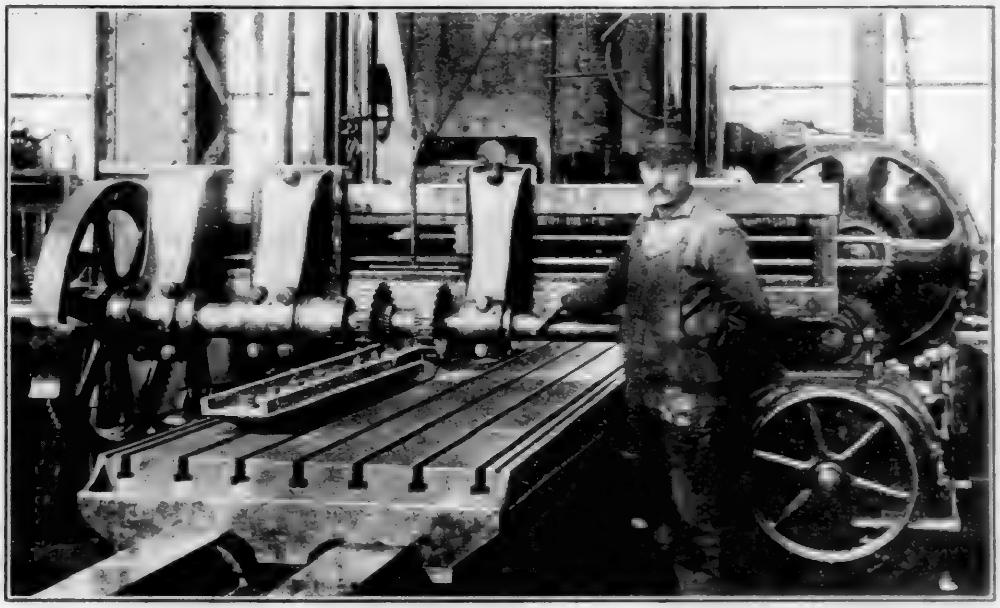


FIG. 7.—FINISHING THE TOPS AND OUTSIDES OF THE FLANGES OF CAST STEEL CROSS-HEAD SHOES.

MECHANICAL DEPARTMENT RECORDS—THE GRAPHIC SYSTEM.

BY L. A. LARSEN.*

To insure satisfactory results in the intricate and manifold interests of railroading, particularly in the mechanical department—to show low costs and high service—an organization must be maintained which shall control the details. These being determined, the results are bound to follow. Among the essential elements of such an organization may be mentioned:

1. Systematic instructions.
   (a) Covering all important matters.
   (b) Complete, concise, and revised as demanded by changing conditions.
2. Assurance that these instructions are being observed, which requires
   (a) Familiarity on part of all concerned with them.
   (b) Regular reports, showing returns.
3. Records, showing plainly the results.

This article does not discuss either the first or second, which deserve separate attention, but treats only of records in the mechanical department. The elements of a good record are (1) accuracy, (2) permanence, (3) simplicity, (4) comparison. There are, in general, three methods of recording results: (1) as contained in the original reports, (2) in books and statements, (3) the graphic system. Each has something to commend itself. The first two certainly bear the stamp of long usage, but this alone cannot be accepted as final in their defense. It is not our purpose to point out the defects of these methods, though we might do so, but to indicate the merits of the third, or graphic system. It has been only in recent years, since the rise of the technician, that the value of the graphic method has been recognized, and its field of usefulness has been but meagerly covered.

The graphic record, or diagram, is of varying sizes and styles, limited only by the varying demands. The most commonly used diagram is made of smooth, heavy white paper, 19 x 24 ins. in size, ruled at right angles in green or orange (as being best for the eye). The two general varieties are termed, respectively, the daily, one-year diagram, and the monthly, ten-year diagram. As these terms indicate, the first is used to record daily occurrences for a period of one year, the second to record monthly occurrences, expenses, etc., for a period of ten years. Reference to the illustrations will more fully explain them. Fig. 1 is a fac-simile of a part of the daily, one-year diagram. Each perpendicular column, 1-24 in. in width, represents one day, and the record shown covers a month of 31 days. The diagram has 366 of these columns, each month being distinctly shown by a heavy line, each five days also being shown by lines heavier than those distinguishing days, but not so heavy as those separating months. In like manner, the horizontal heavy lines separate spaces of five and twenty-five. These lines do not usually indicate periods of time, but are spaced for facility of calculation, each space being denominated as representing a certain number of cents, dollars, delays, etc., as may be considered most convenient.

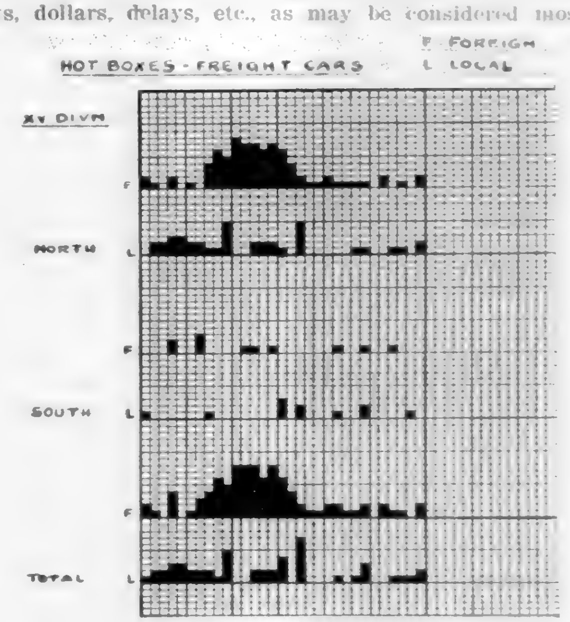


FIG. 1.

Fig. 3 is a fac-simile of a part of the monthly, ten-year diagram, and represents a record for two years. The lightest perpendicular lines separate periods of one month, those slightly heavier periods of six months, while the heaviest distinguish periods of twelve months. The horizontal lines in this diagram, as in Fig. 1, are flexible in their significance, and for convenience heavier lines distinguish certain spaces. The entries are made by using India inks (black, when but one color is needed), or a 6 H drafting pencil. The latter is more convenient, but the former is more nearly permanent.

* Mechanical Department, N. P. Ry.

Each small square in Fig. 1 represents one car, and it will be noted that on January 1st two foreign and no local cars were reported running hot on northbound trains, and no foreign and one local car running hot on southbound trains, or a total of two foreign and one local. The situation had become much more serious by the 10th of the month, the trouble coming almost entirely from foreign cars. This diagram shows the number of freight cars running hot on X Y division each day, direction of movement, and whether a local or foreign car. Each division is shown in the same manner, and at the bottom of the sheet the system totals are given. A glance will tell which division is having the most trouble, in which direction hot box cars are moving (i. e., what terminal apparently is responsible) and whether foreign or local cars require attention.

The daily, one-year diagram may also be used as a monthly, one-year record, as indicated in Fig. 2. This shows a part of the record of a few engines. All parts of the engine from A to Z are shown in their order under "Broken or Defective." Each small square represents one failure, the twelve perpendicular columns representing months. For example: In January engine 500 failed once doubling or stalling, three times not steaming, twice flues leaking, and once burst flue. The engines follow each other in numerical order, which allows a quick comparison between individual engines of the same class. Each diagram carries a complete yearly record of all failures of 30 engines. Inks of different colors are used to distinguish between different divisions. The comparison offered is threefold, between (1) individual engines or class, (2) parts of same engine, (3) divisions. The value of such comparison, which, it should be remembered, can be made at a glance, is apparent.

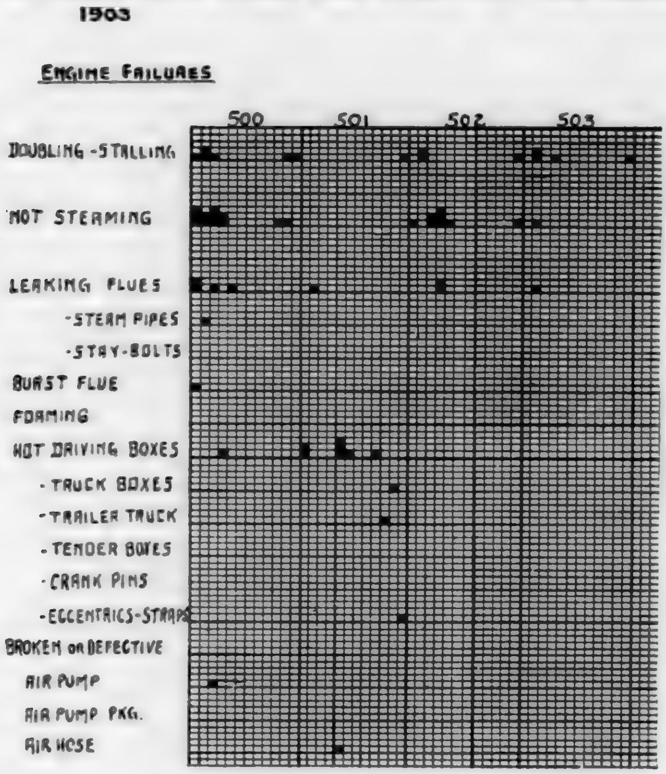


FIG. 2.

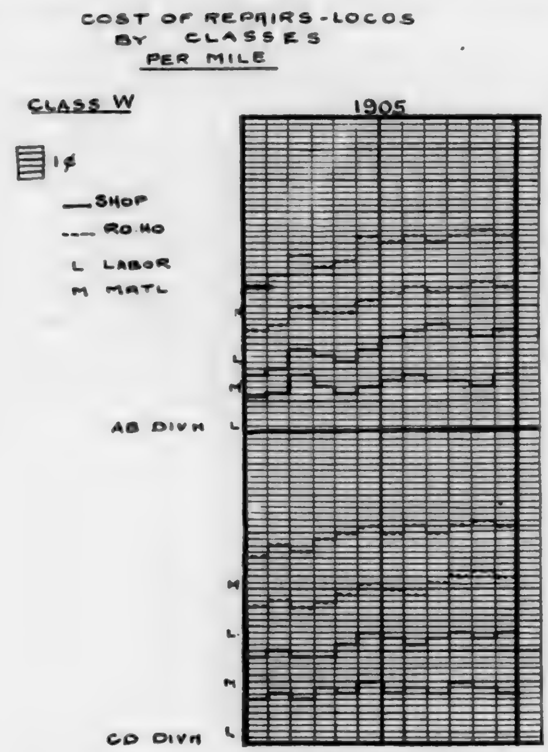


FIG. 4.

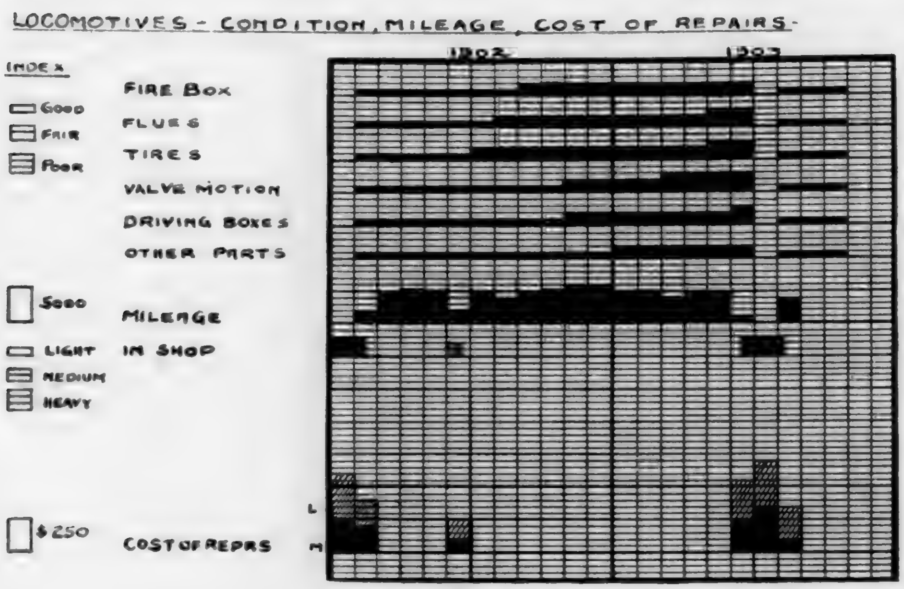


FIG. 3.

The monthly, ten-year diagram is shown in Fig. 3. The perpendicular light lines separate the months, the perpendicular heavy lines separate periods of 12 months. The horizontal heavy lines are base lines from which calculations are made, each block representing a certain number of dollars, cents, miles, etc., as required. Fig. 3 shows the record of one engine. It will be seen that this engine was in the shop undergoing heavy repairs during January and until February 15th. The cost of repairs was: Labor, $550; material, $450; total, $1,000. The condition of the various parts is determined from roundhouse inspection, as good, fair, or poor, according to superintendent of motive power's determinations, and is reported each month. In February the condition of all parts was good, and the engine made 2,000 miles after being turned out of the shop. It was in continuous service until June, when it was in shop for medium repairs on account of being wrecked (this being indicated by cross-hatching on line "in shop"). The cost of repairs this time was $250, including labor and material. By June, 1903, after making about 75,000 miles since general repairs, the condition of the engine had become almost uniformly bad, making it a shop candidate, and it was shopped at a total cost of $1,600; labor, $900; ma-

terial, $700. The comparisons allowed here will occur to the reader. A glance will reveal the condition of an engine as to all vital parts, mileage made each month, when, why, and how long held in shop, cost of repairs, when next due for shopping, etc. One sheet will carry such a record for six engines for ten years.

Figs. 4, 5 and 6 indicate more general records than those above explained, and illustrate respectively records Nos. 11, 12 and 13 in the list given at the end of the article. Fig. 4 is a record of the cost of repairs to class W engines during each month of 1905 on two divisions. Note that shop and roundhouse expense is shown separately and is divided between labor and material. On A. B. division the January cost was $.046 per mile, while on C. D. division the corresponding cost was $.06. Both divisions show an increase from month to month, though for some reason the cost on C. D. division is uniformly higher than on A. B. division. The complete record includes the cost on each division, and total cost for the system. Each class of engine is shown on a separate sheet, so that the number of sheets is determined by the number of classes of locomotives.

Fig. 5 represents a part of the record of the Joyville roundhouse payrolls. Each class of labor is shown separately, and rates are shown in figures, e. g., the machinists' roll in January amounted to $80 (1 man), rate $3.45, in April, May and June from $120 to $130 (2 men). The boilermakers' roll increased from $110 in January to $160 in December. At the foot of the sheet the total roll is shown, e. g., in January it was $1,500, and in December $1,700. A recapitulation sheet showing totals of each roundhouse on the system is also used, allowing a quick comparison of all points. It is a simple matter to compare the roundhouse labor expense from month to month without being cumbered with a lot of statements and figures, and it is as simple to make like comparison between corresponding months or periods of various years.

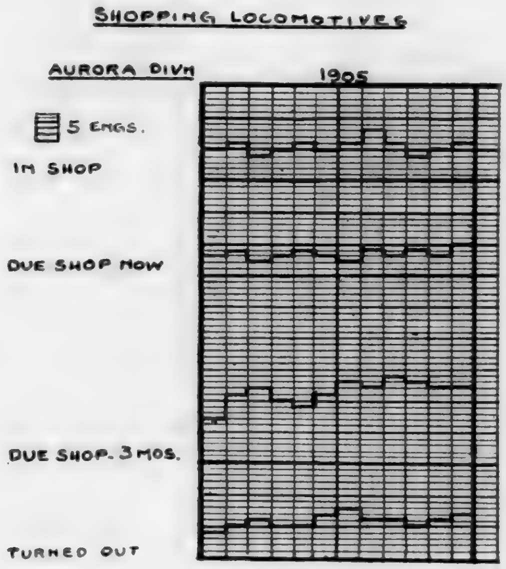


FIG. 6.

Fig. 6 illustrates a record whose object is to keep the superintendent of motive power informed of the condition of his locomotives, and is a complement to the record of condition of individual locomotives, Fig. 3, giving in a concise form as to all engines on a certain division information concerning locomotives which require shopping within a period of 90 days. The monthly condition reports, referred to in the explanation of Fig. 3, indicate in a sufficiently accurate way for all general purposes the engines which should go to the shop at once or within a period of from 30 to 90 days. The payroll of the shop, being, of course, dependent upon the engines in shop, can then be somewhat accurately foreshadowed, so that on roads where a payroll allowance is made at the beginning of each month, such a record is of considerable value. This record also shows how rapidly the engines of each division are turned out, i. e., the shop output, to know which is often important.

Fig. 7.—Note that while E. F. division has been having the least number of engine failures, varying from 50 in January, 1904, to 20 in August, its record on mileage basis is not so satisfactory as that of X. Y. division, and varies from 6,800 miles per failure in January, 1904, to 9,000 in August. It is easy to see that A. B. division is not making an enviable record.

Fig. 8 illustrates two methods of recording results: (1) by lines connected at right angles, (2) by lines connected from point to point. The first six months' record of 1904 is repeated at the right according to the second method, and by some this is preferred.

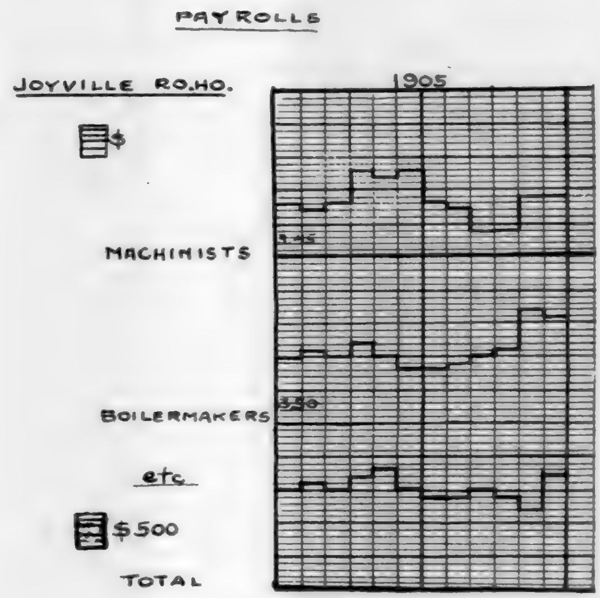


FIG. 5.

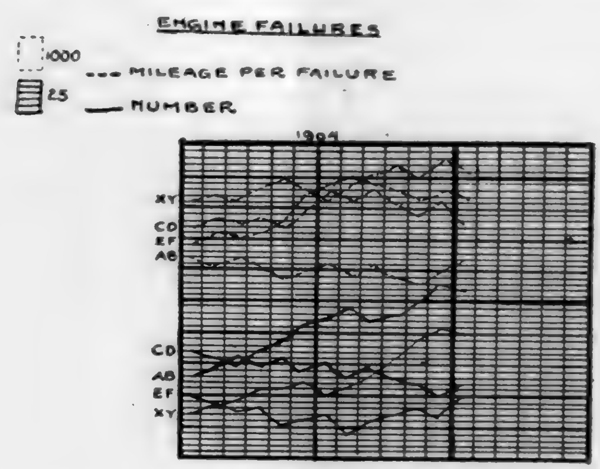


FIG. 7.

In addition to the large office records, the loose leaf diagram book, 4½ x 7 ins., pocket size, may be used to carry the same records. Fig. 8 is a part of such a record, representing the coal consumption, percentage of excess, of two engineers. This record is an important one on lines where account is kept of the consumption of coal by locomotives on an allowance basis. By this I refer to the tonnage system, under which each class of engine is allowed a certain amount of coal per 1,000 ton miles, which varies only among different trains. At the close of each month a compiled statement is issued, showing the amount of coal burned by the engines handled by each engineer, amount allowed, excess consumption, percentage of excess. Inasmuch as the

conditions under which each man works, so far as coal allowance is concerned, are thus practically alike, the saving of fuel is made to be dependent largely upon the personal element, and this diagram record shows plainly what each man is doing. It also indicates the manner in which it may be applied to men as well as things. This book is carried by the master mechanic or road foreman of engines, and each engineman can be shown his record compared from month to month and with that of the men on opposite or similar runs. These loose leaf books, with 150 sheets, sufficient for the records of 300 engineers and 300 firemen for 7 years, cost \$1.75 each; extra leaves, 50c. per 100. The 19 x 24-in. sheets cost about 5 cents each in quantities.

It should be explained that the diagrams themselves do not require that the spaces be filled in solidly in black, as shown in Figs. 1 and 3 (this being required in the text only to make the illustrations clear). The lines, being black on a background of green, stand out singly, and, of course, are connected as additional entries are made. It should also be understood that the various illustrations given do not indicate actual results on any certain road, but do represent records actually kept.

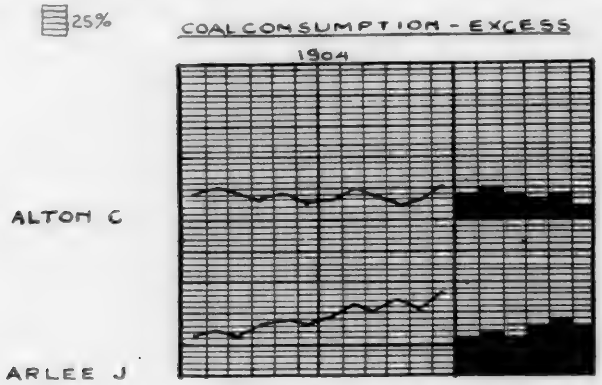


FIG. 8.

As indicating the variety of records which are in actual use, the following may be mentioned:

1. Hot Boxes—Freight Cars—Division, Direction, Foreign or Local, Number Daily, Totals.
   Hot Boxes—Passenger Cars—Direction, Car No., Division, System Totals.
2. Cylinders and Triples Cleaned—Freight Cars—Number Per Month, Stations, Division, System Totals.
3. Slid Flat Wheels—Freight, Passenger, Locomotive, Number Removed, Mileage Per Pair, Each Division, System Totals.
4. Lighting Passenger Cars—Comparative Cost—Pintsch, Acetylene, Electricity.
5. Defective Air Hose Removed—Number, Cause, Manufacturer, Average Life of Each.
6. Repairs to Cars—Freight and Passenger—Total, Labor and Material, Mileage, Cost Per Mile, Etc.
7. Consumption of Oil—(1) Locomotive—Miles Per Pint, Valve, Engine, Etc., Cost Per 1,000 Miles.
   Consumption of Oil—(2) Cars—Freight and Passenger—Miles Per Pint, Cost Per 1,000 Miles.
8. Engine Failures—(1) Individual Engines, Nature of Failure,, Date, Division.
   Engine Failures—(2) Total, Divisions, Miles Per Failure.
9. Coal Consumption—(1) Ton and Engine Mileage Per Ton, Various Divisions, Passenger, Freight and Other Classes of Service.
   Coal Consumption—(2) Various Classes of Engines, Comparing Actual With Allowance.
   Coal Consumption—(3) Various Classes of Trains, Comparing Actual With Allowance.
10. Boiler Work—Fireboxes, Flues, Side Sheets, Etc., Applied to Individual Engines, Number, Date.
11. Repairs to Locomotives—(1) By Classes, Cost Per Mile, Labor and Material, Shop and Roundhouse.
    Repairs to Locomotives—(2) Total Cost, Cost Per Mile, Labor and Material, Shop and Roundhouse.
12. Pay Rolls—Actual, Each Month, Each Class of Labor, Stations and Divisions.
13. Shopping Locomotives—Number in Shop, Turned Out, Due in 30 Days, Due in 60 Days, Divisions.
14. Gasoline Used at Water Stations and Coal Docks—Gallons Each Month, Cost of Pumping, Etc.
15. Coal Used at Stationary Plants, R. H. and Shop—Tons Each Month, Each Plant.

The advantages of the graphic record are many; certain may be mentioned:

1. They are simple, concise, handy, easily made and understood.
2. Their first cost, as well as the labor cost of maintaining, is nominal.
3. They are permanent and carry complete data for from one to ten years.
4. They admit of quick and accurate comparisons such as can be made in no other way, as to time, costs, stations, divisions, etc., limited only by the varieties of subjects considered.

In a word, the graphic system is immediate and final in its results, and combines in an eminent degree the elements of a good record: accuracy, permanence, simplicity and comparison.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE, PACIFIC TYPE.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

Thirty of these engines have been built by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fe Railway. This is the second application of the Vauclain 4-cylinder balanced compound arrangement to Pacific type locomotives, the first application having been made to the Oregon Railroad & Navigation Company's locomotives, which were described on page 246 of our July issue. The weight of the Santa Fe engine, as given below, was taken with two gauges of water and a steam pressure of 120 lbs., while the weight of the O. R. & N. engine was taken with three gauges of water and 200 lbs. steam pressure, and, therefore, the weight of the two locomotives under similar conditions would be about the same. The Santa Fe engine, however, weighs considerably more on drivers and is also considerably more powerful, having a tractive power of 32,800 as compared to 28,000 lbs. for the O. R. & N. engine. The cylinders of the two locomotives are of the same size, but the driving wheels for the Santa Fe engine are 4 ins. less in diameter and the steam pressure is 20 lbs. greater.

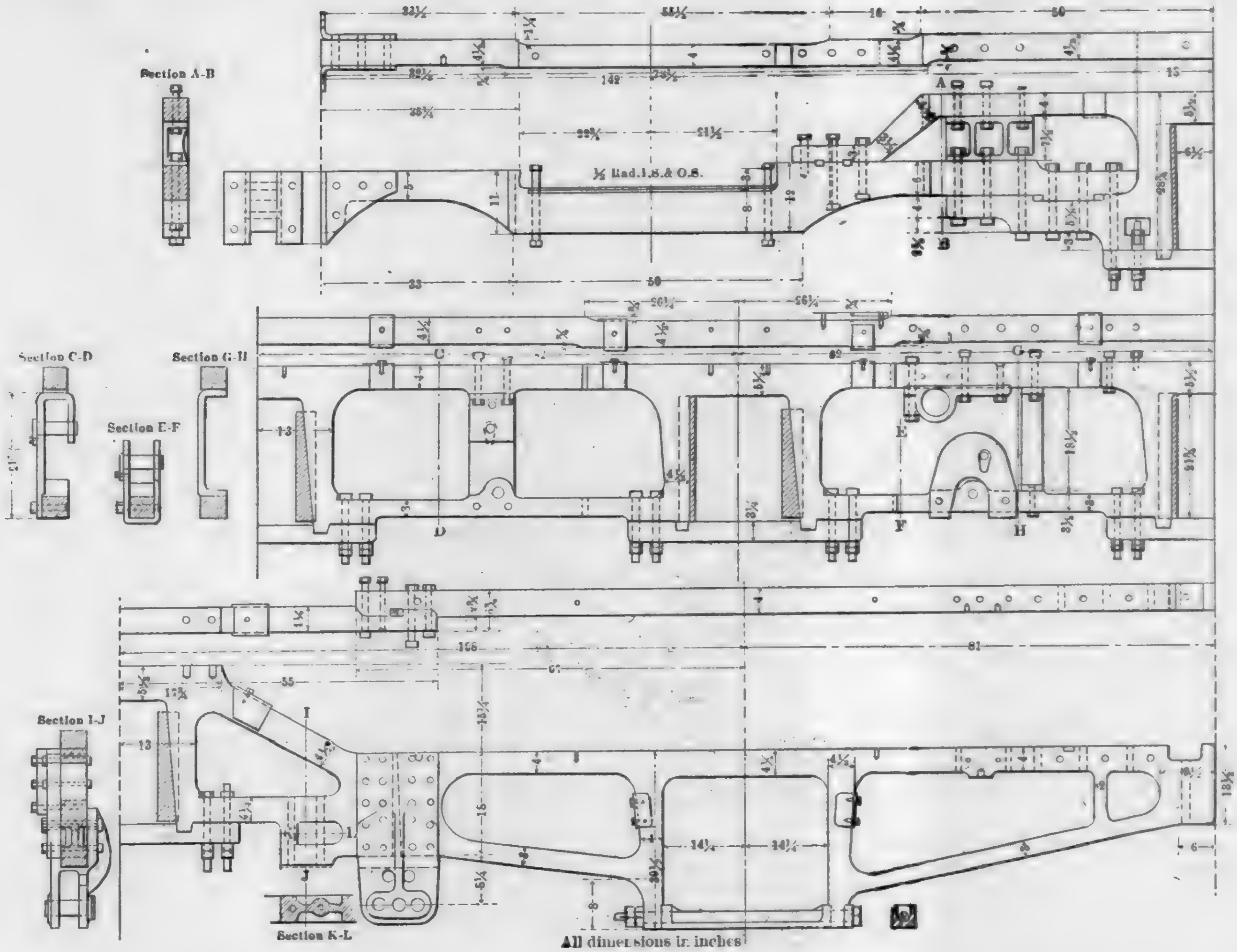
The Santa Fe engines have a built up crank axle, this being more easily manufactured and the metal being more uniform than in the forged crank axles used on the O. R. & N. engines.

A safety strap made of a ½-in. steel plate is fastened to the boiler and has a brass collar which fits over this axle at the centre to guard against damage if for any reason the axle should break. The engines are equipped with a traction increaser of the same design, as used on the Santa Fe Atlantic type engines. As it was desired to have the driving wheels and axles interchangeable as far as possible with those used on the single expansion type locomotives and as it was necessary to have a greater width between the frames at the cylinders and at the main driving wheels on the balanced compound engine the cast steel frame is offset and made wider at these two points as shown in the accompanying drawing. The bifurcated rod is of the same design as used on the O. R. & N. engine, as shown in detail on page 246, except that it is a little longer. The engine is arranged for burning oil and the tender has a capacity of 8,500 gals. of water and 3,300 gals. of oil. A list of dimensions follows:

PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE—ATCHISON, TOPEKA & SANTA FE RAILWAY.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Oil.
Tractive power	32,800 lbs.
Weight in working order (2 gauges water)	226,700 lbs.
Weight on drivers	151,900 lbs.
Weight on leading truck	35,800 lbs.
Weight on trailing truck	39,000 lbs.
Weight of engine and tender in working order	402,783 lbs.
Wheel base, driving	13 ft. 8 ins.
Wheel base, total	34 ft.
Wheel base, engine and tender	66 ft. 1½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.63
Tractive effort x diam. drivers ÷ heating surface	666
Total weight ÷ tractive effort	6.91
CYLINDERS.	
Kind	Compound.
Diameter and stroke	17 and 28 by 28 ins.
Valves	Piston.
WHEELS.	
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	11 by 10 ins.
Driving journals, others, diameter and length	9 by 12 ins.
Engine truck wheels, diameter	31¼ ins.
Engine truck, journals	6 by 10 ins.
Trailing truck wheels, diameter	48 ins.
Trailing truck, journals	7½ by 12 ins.
BOILER.	
Style	wagon top.
Working pressure	220 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108 by 71¼ ins.
Firebox, depth, front and back	78¾ and 68¼ ins.

VAUCLAIN 4-CYLINDER BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE—ATCHISON, TOPEKA & SANTA FE RAILWAY.



CAST STEEL FRAMES FOR SANTA FE PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE, SHOWING OFFSET AT THE CYLINDERS AND AT THE MAIN DRIVING WHEELS.

Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ ins. front, 5 ins. sides, 4 ins. back.
Tubes, number and outside diameter	290, 2¼-in.
Tubes, gauge and length	11, 20 ft.
Heating surface, tubes	3,402.2 sq. ft.
Heating surface, firebox	192.8 sq. ft.
Heating surface, total	3,595 sq. ft.
TENDER.	
Wheels, diameter	34¼ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	8,500 gals.
Oil capacity	3,300 gals.

CUTTING WATER GAUGE GLASSES.—Take a match and cut it; wet the head thoroughly. Having measured the glass, put the wet match-head inside the glass where it is to be cut and turn the glass around several times till a ring is formed on the inside. Then take another match, and having lit it, hold the flame under the mark around the inside, when the operation is complete.—*American Machinist.*

The executive committees of the Master Car Builders' and the Master Mechanics' associations will meet at the Manhattan Hotel, New York, December 11th, and it is expected that the location for the June conventions will be decided upon at that time.

FAST RUN ON THE PENNSYLVANIA.—On November 4th the Pennsylvania westbound 18-hour train left Harrisburg, Pa., two hours late and arrived in Chicago on time. This distance of 717 miles was covered in 741 minutes, the average speeds over different sections being as follows: From Harrisburg to Altoona, 132 miles, 67.8 miles per hour; from Altoona to Pittsburgh, 117 miles, 48.15 miles per hour; from Pittsburgh to Crestline, 55.5 miles per hour, and from Crestline to Chicago, 279 miles, 63.4 miles per hour.

54- INCH RAPID PRODUCTION BORING AND TURNING MILL.

A 54-in. rapid production boring mill, which is the latest development in the Bullard boring and turning mills, is shown in the accompanying illustrations. It has a capacity for work 56 in. in diameter and 42 in. in height; the table is 52 in. in diameter and is driven by a large steel spur pinion meshing with an internal gear of as large diameter as the size of the table will permit. The table has a self-centering tendency, due to the large angular thrust bearing shown in Fig. 3. The side strains are taken by vertical bearings, and the weight of the table and the spindle, as well as the work on the table, tends to preserve the alignment.

An important feature of the machine is that every movement or adjustment, except for the left hand head, may be made by the operator without moving from his position. Fifteen table speeds are obtained from the speed box, which is shown at the extreme right of Fig. 1, and from the head stock which is mounted on the bed between the housings (Fig. 2). The head stock furnishes three speeds, and any one of these may be obtained by means of lever A, which operates positive clutches. The pilot wheel B controls the changes in the speed box, each spoke indicating one speed, which is engaged only when its corresponding spoke is in a vertical position. The brake lever C, which is on the same shaft as the pilot wheel B, is operated by lifting. This brake allows the table to be instantly stopped at any point, and can be applied only when the frictions are disengaged, and the pilot wheel spoke is in a neutral position; it is impossible to turn the pilot wheel while the brake is on. The lever, which controls the changes in the head stock gearing, can only be operated when the brake is set, and it in turn locks the brake lever until the gearing is fully engaged. This inter-locking arrangement safeguards the driving mechanism from careless handling, but does not interfere with the rapid manipulation of the machine, a change from the highest to the lowest speed being made in a very few seconds. The machine may be driven from a countershaft or by a 15 h.p. constant-speed motor mounted on the bracket between the housings, as shown in Fig. 2. This bracket is so designed that if desired the motor may be suspended and gears or silent chain sprockets may be substituted for the belt pulleys.

The feeds are independent for each head, have ten changes ranging from 1-32 to ¾ of an inch for each revolution of the table, and are readily changed or reversed by levers D, E and F. A notable feature in connection with the feeds is the entire elimination of pull gears and crank handles at the ends of rods and screws; pull gears being replaced by gears constantly in mesh, and change from vertical to cross feed, or vice versa, being made by adjustable friction clutches operated by the lever H. This device multiplies many times the value of the rapid traverse and serves the purpose of a safety slip point in an otherwise positive train of feed gears, obviating all chance of breakage and delay through careless handling.

Rapid power traverse of the head and tool bar is obtained from the vertical feed rod, the cone frictions at its upper end being engaged by the horizontal lever G, shown at its lower end. In its central position the feeds are engaged, but by raising or lowering the lever the clutch is released and the cone frictions brought into contact with a high speed top shaft and the rod revolved at a high rate of speed. The connection between the feed box and feed rod is a claw clutch, so arranged as to engage in but one position; the rapid

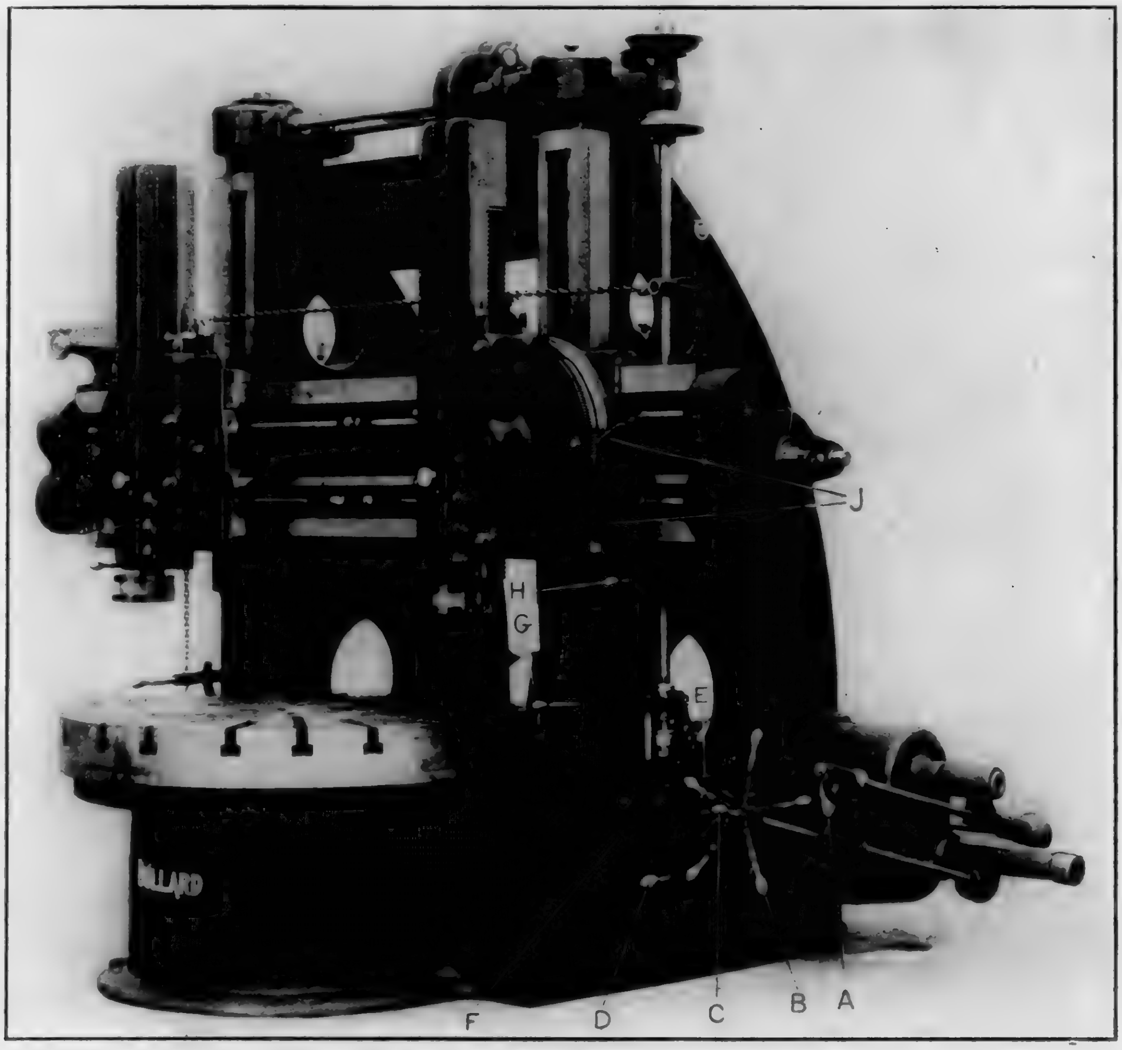


FIG. 1.—BULLLARD 54-INCH RAPID PRODUCTION BORING MILL.

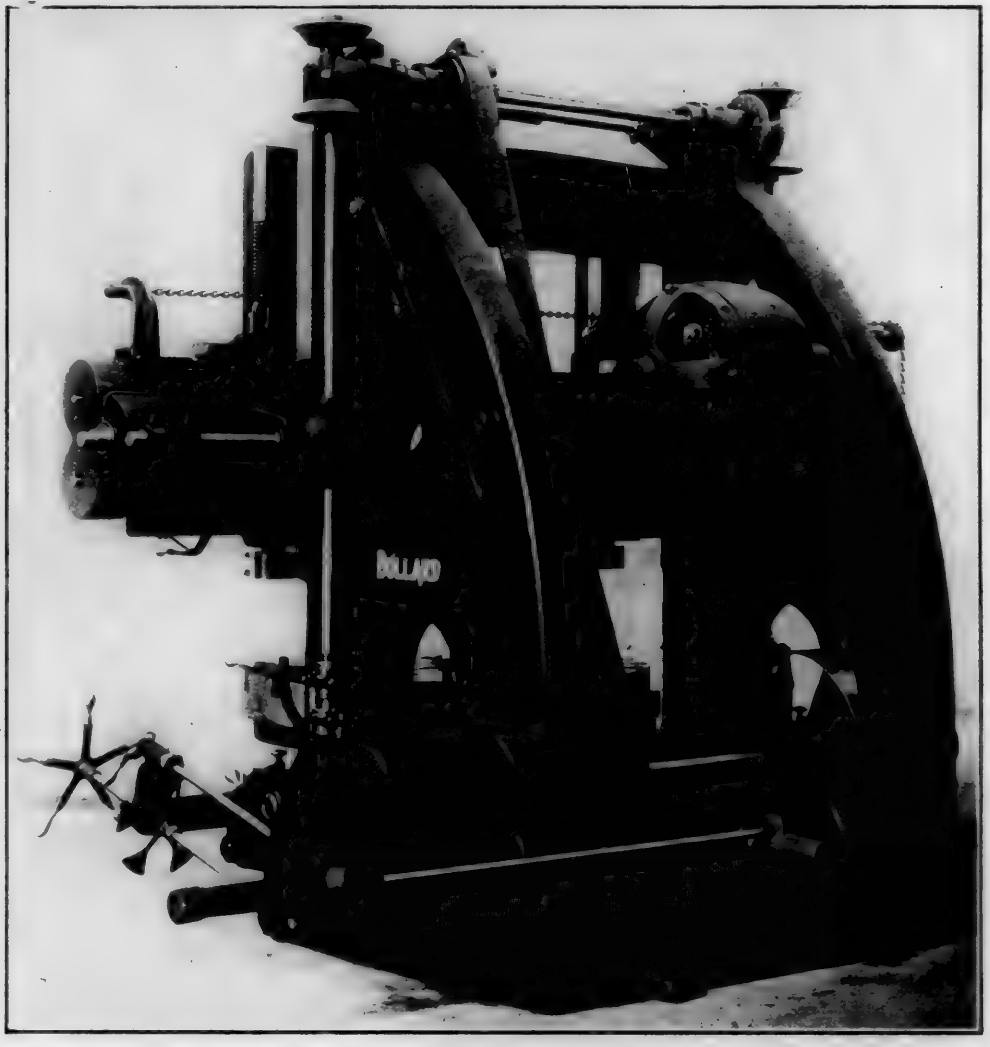


FIG. 2.—REAR VIEW OF BULLARD BORING MILL, SHOWING APPLICATION OF MOTOR DRIVE.

traverse may be used in thread cutting with no danger of a split thread resulting. The feeds are reversed in the feed box, so the position of the traverse lever bears a constant relation to the direction of movement in the head and bar, confusion in the mind of the operator being entirely obviated.

Fine adjustment of the cutting tool is made by the double acting ratchet levers J, shown attached to saddle. These ratchets automatically release their grip when actuating pressure is relieved. This device renders it possible for the operator to set the tool to the proper depth of cut or the diameter required at close range and saves the time consumed in going to the end of the rail to make adjustments as in the case of the ordinary machine having crank handles.

The construction of the rail is a feature which adds much to the rigidity and accuracy of the mill, as the entire weight of the head is supported by the bearing at the bottom of the rail, the upper bearing serving only to resist the tendency of the head to tilt forward under the pressure of the cut. The feed screw is in the centre of the long, narrow, guide bearing, consequently there is no tendency to cant and bind on the rail as in the usual construction. This principle of a guide bearing having a greater proportion of length to width is also used in maintaining the alignment of the centre stop on the rail, the rail being held central by a gibbed block having its bearing in the recess in the face of the right-hand housing.

Another notable feature is the method of driving the top shaft which operates the rail lifting screws. The change in direction of movement is secured by tumbler gears, the driving pinion of which is cut in the end of a quill which is a running fit on the top shaft, the driving key being located in the middle of shaft in order to equalize the torsion between the ends.

Lubrication of all parts subject to wear has received special attention. Both the headstock and speed box are entirely enclosed and the splash system of oiling is used, the gears running in a constant bath of oil. All high speed shafts have ring or chain oiling boxes and gauges are so placed as to indicate the amount of oil in each. The angular thrust bearing of the main spindle is entirely immersed, oil pockets in the bed insuring ample lubrication of its entire surface, while a felt ring feeds oil to the vertical journals. In Fig. 3 will be seen the main features of this bearing, also the indicator for proper oil level at the left side of the bed. This machine weighs about 17,500 lbs., and is made by the Bullard Machine Tool Company, Bridgeport, Conn.

Railroad Y. M. C. A.—From May 1st, 1903, to May 1st, 1905, the number of associations increased from 194 to 207; the number of buildings from 114 to 130; the membership from 62,348 to 74,324; the average daily attendance from 27,831 to 33,951; the rest rooms used from 841,179 to 1,144,457; students in educational classes from 1,851 to 2,664, and the students in Bible classes from 2,883 to 4,183. The rapid growth during the past two years is very encouraging.

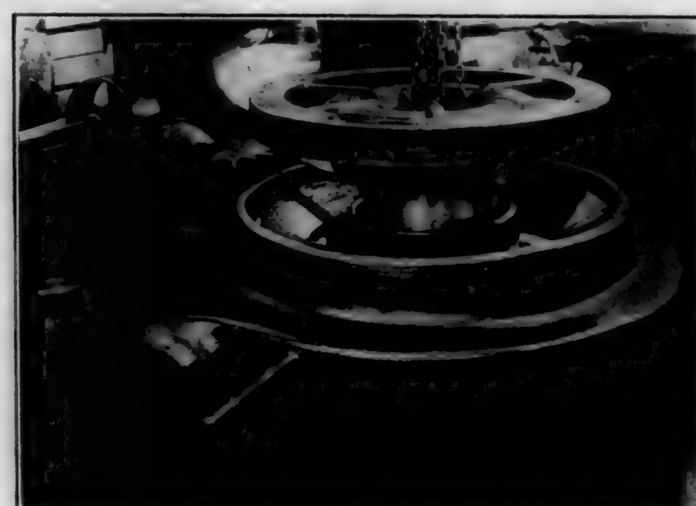


FIG. 3.—ANGULAR THRUST AND VERTICAL BEARINGS OF BULLARD BORING MILL.

Technical Publicity Association.—At a meeting and banquet of this association, held at the Aldine Club, New York, November 3d, the following officers were elected. President, C. B. Morse, Ingersoll-Rand Company; 1st Vice-Pres., H. M. Cleaver, Niles-Bement-Pond Company; 2d Vice-Pres., Frank H. Gale, General Electric Company; Secretary, Rodman Gilder, Crocker-Wheeler Company; Treasurer, H. M. Davis, Sprague Electric Company; members of Executive Committee: Graham Smith, Westinghouse Companies and Chas. M. Manfred, Johns Manville Company. Mr. H. M. Davis addressed the association on "The Advertising Appropriation."

54-INCH RAPID PRODUCTION BORING AND TURNING MILL.

A 54-in. rapid production boring mill, which is the latest development in the Bullard boring and turning mills, is shown in the accompanying illustrations. It has a capacity for work 56 in. in diameter and 42 in. in height; the table is 52 in. in diameter and is driven by a large steel spur pinion meshing with an internal gear of as large diameter as the size of the table will permit. The table has a self-centering tendency, due to the large angular thrust bearing shown in Fig. 3. The side strains are taken by vertical bearings, and the weight of the table and the spindle, as well as the work on the table, tends to preserve the alignment.

An important feature of the machine is that every movement or adjustment, except for the left hand head, may be made by the operator without moving from his position. Fifteen table speeds are obtained from the speed box, which is shown at the extreme right of Fig. 1, and from the head stock which is mounted on the bed between the housings (Fig. 2). The head stock furnishes three speeds, and any one of these may be obtained by means of lever A, which operates positive clutches. The pilot wheel B controls the changes in the speed box, each spoke indicating one speed, which is engaged only when its corresponding spoke is in a vertical position. The brake lever C, which is on the same shaft as the pilot wheel B, is operated by lifting. This brake allows the table to be instantly stopped at any point, and can be applied only when the frictions are disengaged, and the pilot wheel spoke is in a neutral position; it is impossible to turn the pilot wheel while the brake is on. The lever, which controls the changes in the head stock gearing, can only be operated when the brake is set, and it in turn locks the brake lever until the gearing is fully engaged. This inter-locking arrangement safeguards the driving mechanism from careless handling, but does not interfere with the rapid manipulation of the machine, a change from the highest to the lowest speed being made in a very few seconds. The machine may be driven from a countershaft or by a 15 h.p. constant-speed motor mounted on the bracket between the housings, as shown in Fig. 2. This bracket is so designed that if desired the motor may be suspended and gears or silent chain sprockets may be substituted for the belt pulleys.

The feeds are independent for each head, have ten changes ranging from 1-32 to ¾ of an inch for each revolution of the table, and are readily changed or reversed by levers D, E and F. A notable feature in connection with the feeds is the entire elimination of pull gears and crank handles at the ends of rods and screws; pull gears being replaced by gears constantly in mesh, and change from vertical to cross feed, or vice versa being made by adjustable friction clutches operated by the lever H. This device multiplies many times the value of the rapid traverse and serves the purpose of a safety slip point in an otherwise positive train of feed gears, obviating all chance of breakage and delay through careless handling.

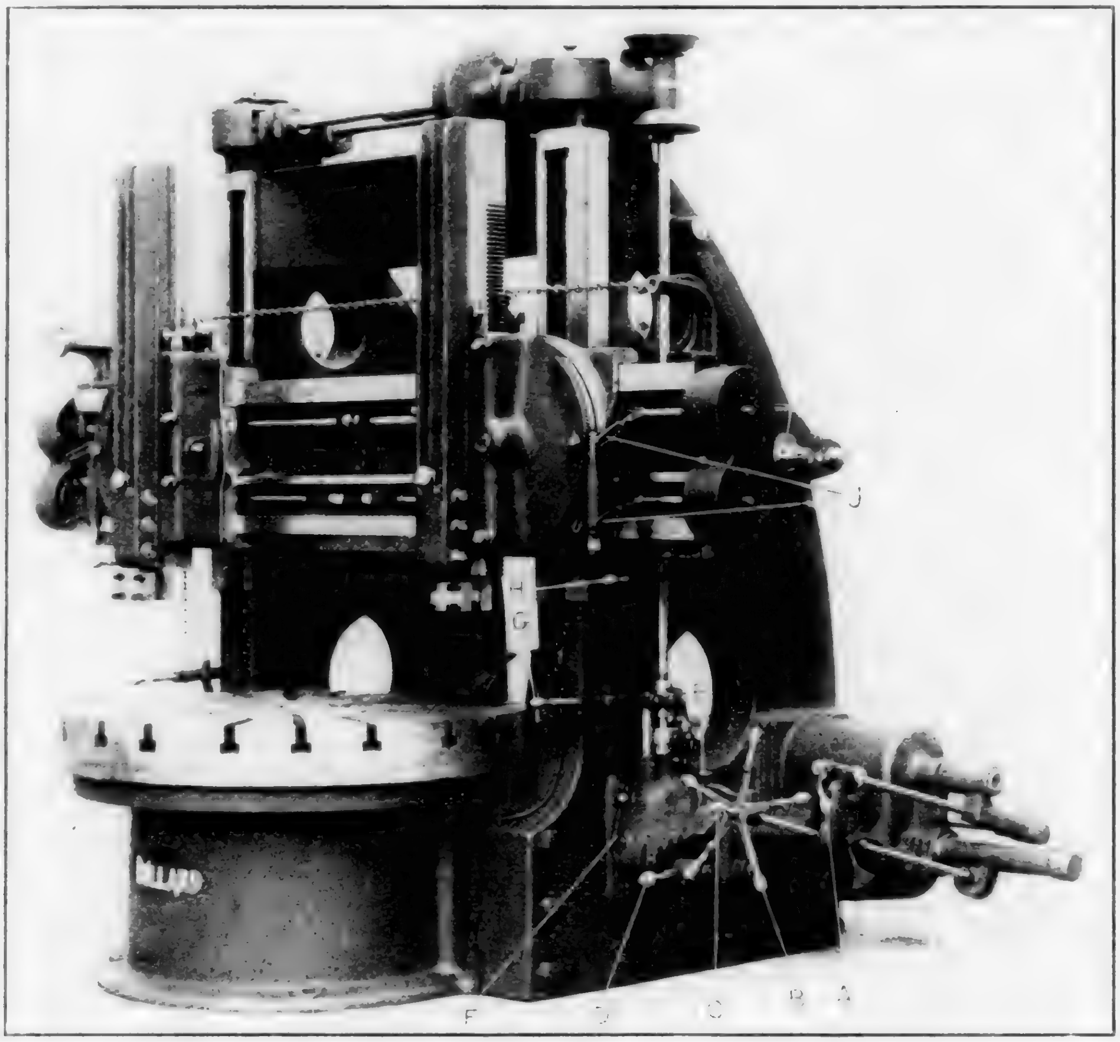
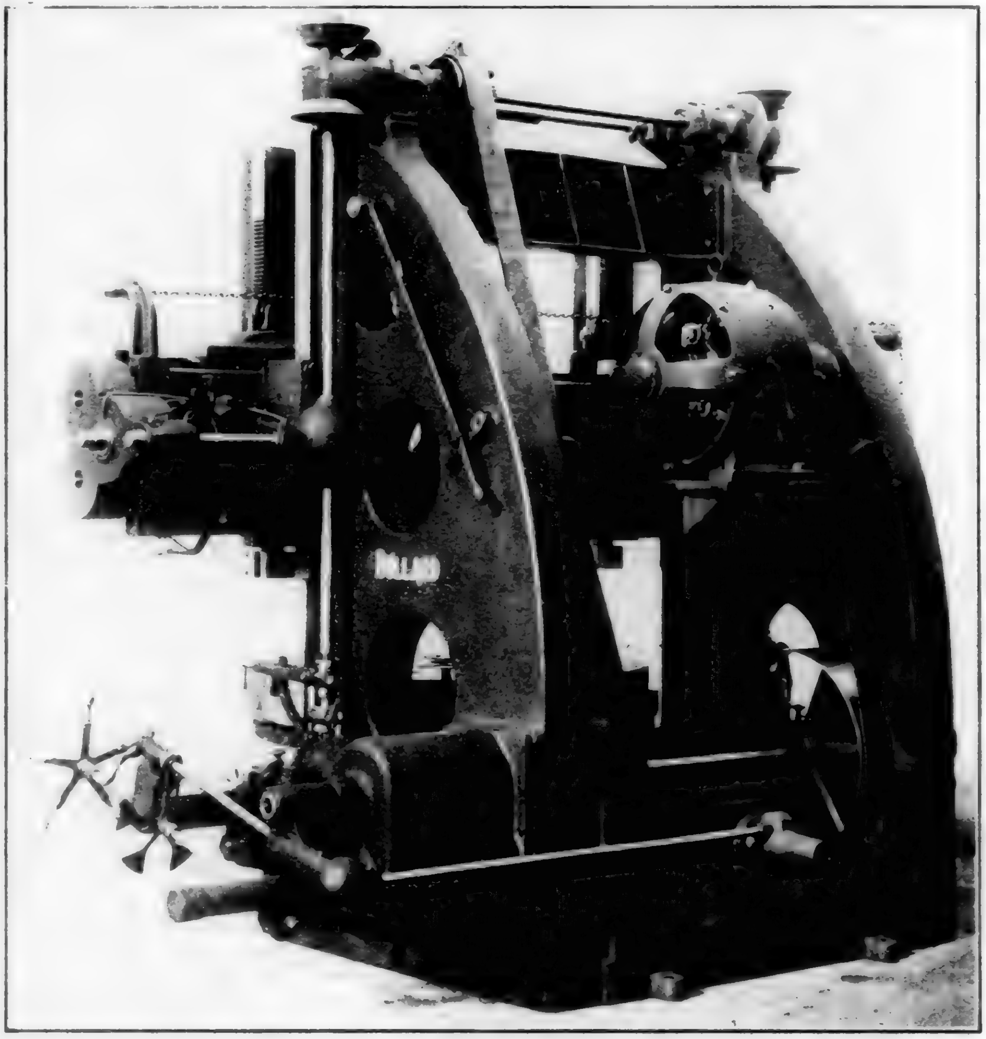


FIG. 1.—BULLARD 54-INCH RAPID PRODUCTION BORING MILL.

Rapid power traverse of the head and tool bar is obtained from the vertical feed rod, the cone frictions at its upper end being engaged by the horizontal lever G, shown at its lower end. In its central position the feeds are engaged, but by raising or lowering the lever the clutch is released and the cone frictions brought into contact with a high speed top shaft and the rod revolved at a high rate of speed. The connection between the feed box and feed rod is a claw clutch, so arranged as to engage in but one position; the rapid



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Lubrication of all parts subject to wear has received special attention. Both the headstock and speed box are entirely enclosed and the splash system of oiling is used, the gears running in a constant bath of oil. All high speed shafts have ring or chain oiling boxes and gauges are so placed as to indicate the amount of oil in each. The angular thrust bearing of the main spindle is entirely immersed, oil pockets in the bed insuring ample lubrication of its entire surface, while a felt ring feeds oil to the vertical journals. In Fig. 3 will be seen the main features of this bearing, also the indicator for proper oil level at the left side of the bed. This machine weighs about 17,500 lbs., and is made by the Bullard Machine Tool Company, Bridgeport, Conn.

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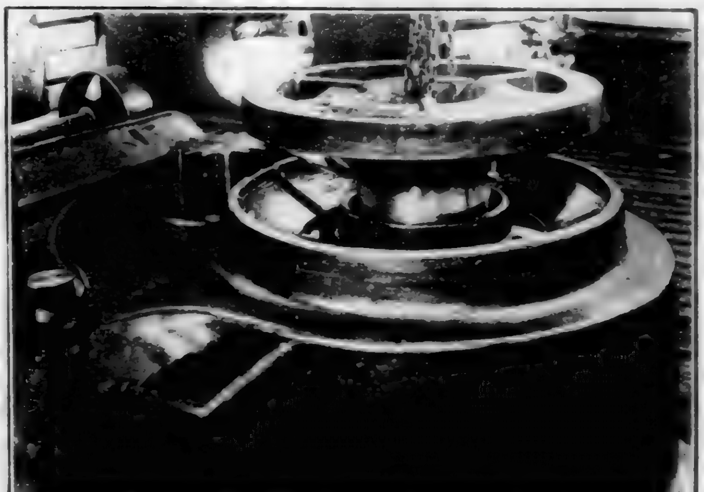

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OIL FURNACES.

The following is taken from a paper presented before the National Railroad Master Blacksmiths' Association by Mr. J. G. Jordan:

What I believe to be the most important point in constructing an oil furnace so that it will work properly is to have sufficient air or fan blast to cause the proper combustion in the furnace. In order to do this you must have not less than eight ounces of fan blast, or from 60 to 75 lbs. of air pressure, to cut your oil or spray it properly into the furnace. The construction of the burner also forms a very important item in the successful operation of an oil furnace. We have many kinds of burners in the different furnaces in our shops, such as steam, compressed air and fan blast burners. We use only air and fan blast in the blacksmith shop, as we believe them to be the best. I tried steam burners, but they do not work well on account of the water in the steam, which prevents getting a good welding heat on the iron. We have one large scrap, or axle, furnace, in which we heat 10-in. driving axles. It is operated with a 10-oz. fan blast, three burners at one end, and stack at other end, and has two doors. The burners are made of 3-in. gas pipe, with ⅜-in. oil pipe in center. In constructing pipe burners you should have the oil pipe back of blast pipe, and 1½ ins. from the end of same, and protected by about 2 ins. of extra fire brick inside the furnace. Without this arrangement you will experience great difficulty in keeping the oil pipe clear of the severe heat with which it comes in contact inside the furnace. There should be a combustion chamber on every scrap furnace, or a firebox about 3 ft. wide, with a bridge extending well over the burners, so that the oil will have no possible chance to come in contact with the piles of scrap or slabs in the furnace. If the oil does come in contact with the slabs, you will have black seams or streaks in the forging, and when it is planed or turned up the forging will be condemned. This, of course, makes no difference in any but a welding furnace.

A bolt furnace should have a water front and a continuous stream of cold water running into the bottom of the water front, and the hot water running out through a waste pipe at the top. In this way the heat in front of the furnace will be diminished, which makes it much more comfortable to the man heating the iron. A bolt furnace should have two burners, one at each end, so that in case one burner gets out of working order the other can be used. In all cases you must use blast in both burners, and oil in only one; otherwise, the burner which is not working will be damaged or ruined by the excessive heat. We use from 40 to 50 gals. of fuel oil in ten hours in one of these bolt furnaces.

A spring furnace should have a combustion chamber, or firebox, and a stack to carry off the gases arising from the oil, so the springmaker can stand close to the door at all times with comparative comfort, in order to gauge the oil to keep the furnace at the same degree of heat and prevent overheating the steel. Our spring furnace has two burners at one end and stack at the other. It has a firebrick floor, and is large enough to heat the longest spring leaves.

The construction of a flue furnace differs materially from any other, on account of the short heat taken in welding the scarf end on the flue. A flue furnace should have a combustion chamber, and from it should lead a narrow passageway (say about 4 ins. square) to where the flame comes in contact with the flue. After it passes the flue there should be a stack to draw off the blaze. If you have no stack you will get too long a heat on the flue, and it will be almost impossible for the flue-welder to stand by his machine, on account of the intense heat and the gases arising from the oil. With the old coke furnace 200 flues was a good day's work, while with one of these oil furnaces 400 flues can be welded in ten hours with ease.

In regard to the kind of furnace best adapted for a bulldozer, for heating arch bars, and all other work that needs forming or bending, I would suggest that it be wide enough to accommodate the longest piece of iron to be bent. Also that it have one door opposite the one out of which you are working, so when you have a piece of iron of extraordinary length you can put it through the opposite door. It should have two burners at one end and a stack at the other, to draw off the surplus heat and gases, so that you can put your machine close to the furnace door and save the unnecessary expense of handling the material a distance. No combustion chamber or firebox is necessary with this furnace, as no welding is done with it, and the burners can be run right into the furnace.

There is another kind of furnace that I wish to call your attention to, and that is a special furnace built for use in straightening steel underframing for freight cars. When cars are wrecked, as you know, it does everything to them except tie them in a knot. In some cases they are 20 ins. wide and 40 ft. long, so I built a special furnace for them. This furnace is 9 ft. long, 30 ins. wide, and has two air burners on one side and two doors, one at each end, so that we can run the sheets clear through and heat them at any place where they are bent. This is a very good furnace for this class of work, as you can erect them at any place needed, and with very little expense can run air into it, and set out a car of oil next to it. The oil cars are of sufficient height to run the oil into the burners by gravity. By this process you can take an 8-ft. heat on a sheet ½ in. thick in about five minutes.

In conclusion, I wish to say that I am a firm believer in oil furnaces, as the work that we turn out with them is double and over, and sometimes treble, the work done with coal or coke. Even if oil was considerably higher and coal proportionately low, it would pay to use oil on account of the greater output of work.

HOW STEEL AXLES FAIL.

Coming now to actual conditions of service, in a car-axle, for example, the maximum fiber-stress allowable by calculation is from 18,000 to 20,000 lbs. per sq. in. in certain parts of the axle, and 7,000 to 10,000 or 12,000 lbs. in other parts. The experience of the Pennsylvania Railroad indicates that, with this maximum calculated fiber-stress, if the metal used in car-axles is steel of not above 65,000 or 70,000 lbs. tensile strength, the axle will sooner or later fail in service. The method of failure is peculiar and worth a word of remark. For example, instead of the journal breaking off from the axle suddenly, due to shock (as we are quite accustomed to see things break), apparently the metal that has the maximum fiber-stress begins to break without any elongation or stretch. This, of course, will be at the surface of the journal, usually at the fillet of the shoulder. A single fiber, if we may use the expression, having broken, the next fiber underneath it receives the maximum fiber-stress slightly increased, and it ultimately fails, and so on, until after a while there will be quite a large portion of the section of the axle broken off in this manner. Then some sudden shock breaks the rest of it and the journal drops off. This breaking of the parts subjected to the maximum fiber-stress, a little at a time, is known as "detail fracture," or sometimes as "progressive fracture." It is a real difficulty and occurs in many places besides car-axles.

With our present knowledge of the subject, the remedy for the failure of a part due to detail fracture is twofold: (1) Either increase the size of the part, which with the same loads will diminish the fiber-stress, as is clearly evident, or, (2) change the nature of the steel, so that the ratio between the calculated maximum fiber-stress and the ultimate tensile strength will be greater; that is to say, if we may trust the experience of the Pennsylvania Railroad, if the maximum fiber-stress between wheels is 20,000 lb. and a steel of 65,000 or 70,000 lb. tensile strength is used sooner or later there will be failures in the car-axles between the wheels. On the other hand, with exactly the same sizes and loads, and consequently the same maximum fiber-stress, if the steel used is from 80,000 to 85,000 lb. tensile strength, there will be no failures during the life of the axle.

The point to which I am leading and to which all that I have said is preliminary, is this:—Iron and steel do not behave alike, when subjected to bending-stresses. We think it is perfectly safe to say that a well-made iron car-axle, the metal of which will show in tensile strength from 48,000 to 52,000 lb. per sq. in., will stand successfully the same fiber-stress as steel of 80,000 to 85,000 lb. tensile strength. Just why this is so, I am unable to explain, but there is a very large amount of accumulated experience which seems to indicate that a metal like iron, which is believed to be a bundle of fibers, each one surrounded by slag, and which has within itself the power of the distribution of the strain, is a more reliable metal when subjected to bending stresses than a perfectly homogeneous metal like steel. This is hardly the place or the time to go into a discussion of this phase of the case, and so I close by saying, that the present outlook seems to be that if wrought iron can be made in sufficiently large masses, so that flaws and defective welds will be eliminated, it might again become a successful rival of steel, especially if it can be made at a cost that will permit of commercial competition.—*Dr. Charles B. Dudley, American Institute of Mining Engineers.*

NEW DRAFT APPARATUS FOR HANDLING HOT GASES.

In handling hot gases with a fan, as in a plant producing induced draft for boilers, it is practically impossible to give the fan shaft a suitable bearing at the inlet side, as it would necessarily be situated in the inlet area and would be surrounded by hot flue gases. Much better results have been obtained by the use of an overhung wheel having in addition to the two engine bearings a bearing on the engine side of the fan, but none on the inlet side. This form of construction has, however, given considerable trouble because of the difficulty of lining the third bearing up with the two engine bearings.

FIG. 1.—NEW DRAFT APPARATUS FOR HANDLING HOT GASES.

Fig. 1 shows a new method of construction, which overcomes this difficulty. All three journal boxes are cast in the engine frame and can all be bored with the same boring bar, and will, therefore, be in line. The fan bearing is water cooled and ring oiled. With this arrangement self-aligning bearings are not necessary and the construction is simplified, as the bearing is supported by the engine bed, and not by the housing of the fan, and additional bracing for the fan housing is not required.

The construction of the wheel has also been improved upon. One heavy spider built of I beams cast into the hub is used in place of the ordinary arrangement with three spiders. The blades are braced as shown in Fig. 2. This construction is fully as strong and rigid as the three spider arrangement, and by the use of a single spider the necessity for more than one hub on the shaft is obviated and the load of the wheel is concentrated upon a comparatively short length of shaft. With the deep cone in the casing, as shown in Fig. 1, and the fan bearing setting as far in it, as it does, the distance from the fan housing and the centre of gravity of the fan is very short and the weight of the shaft acting on the fan bearing as a fulcrum does not cause an upward thrust in the engine and on the engine journal caps.

FIG. 2.—NEW TYPE OF FAN WHEEL.

The engine is of the enclosed type and is oiled by a recently designed pump which distributes copious streams of oil over the reciprocating and revolving parts, even lubricating the eccentrics outside of the frame. Tests have shown that it will run several months without oiling or adjustment. This outfit is manufactured by the American Blower Company of Detroit, Michigan.

The record was broken at the Baldwin Locomotive Works during October, when 225 locomotives were turned out. For the first six months of this year 1,000 locomotives were completed.

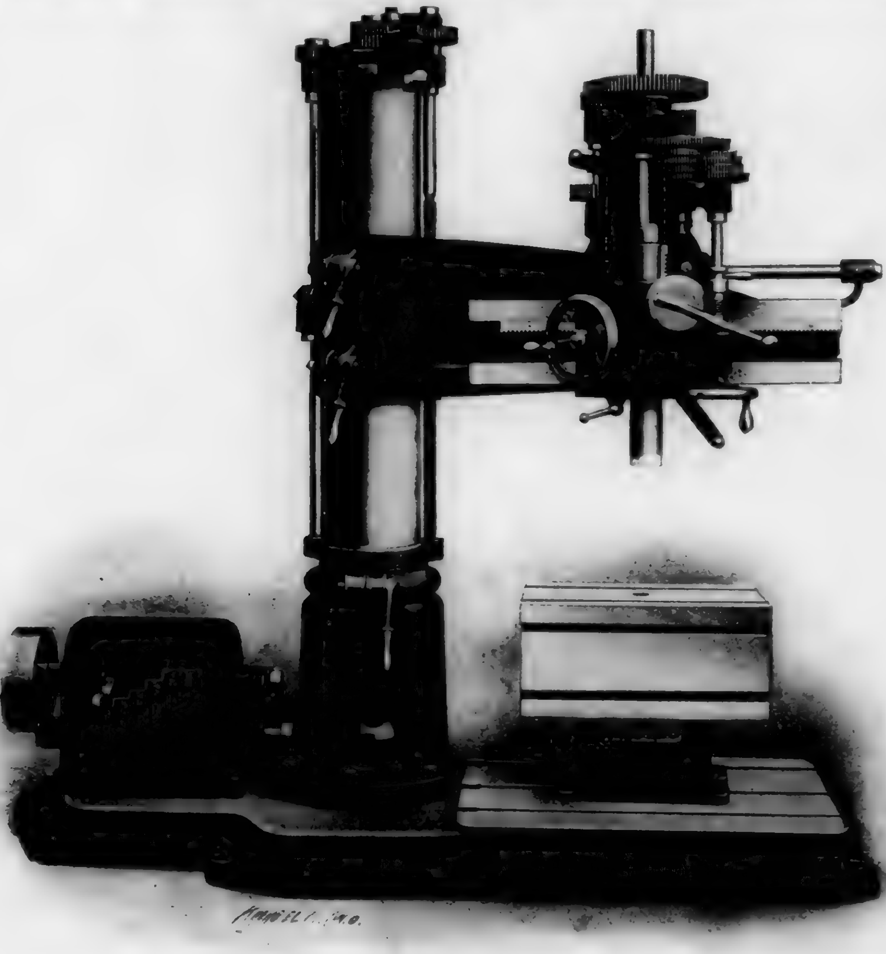
Model Locomotive for Purdue.—Mr. Henry F. Shaw of Boston, well known in railway circles for his devotion to the problem of balancing the reciprocating parts of locomotives, has presented to Purdue University a model locomotive embodying his latest design. The model is constructed on the scale of 1 inch to the foot, and is an excellent piece of work.

Railroad Statistics.—According to the most recent German statistics, the length of the railroads of the world was 537,105 miles on December 31, 1904, of which 270,386 miles were in America, 187,776 miles in Europe, 46,592 miles in Asia, 15,649 miles in Africa, and 16,702 miles in Australasia. Of the mileage of European railroads, Germany stands first (34,016), followed in their order by Russia (33,286), France (28,266), Austria-Hungary (24,261), the United Kingdom (22,592), Italy (10,025), Spain (8,656), Sweden and Norway (7,730). The average cost of construction of the European railroads per mile is estimated at $107,577, while for the remainder of the world the estimate is only $59,680. The total value of the railroads of the world, according to these statistics, is $43,000,000,000, of which the European roads figure for 22,000,000,000. The estimate for rolling stock is as follows, in numbers: Locomotives, 150,000; passenger coaches, 225,000; and freight cars, 3,000,000.—*Consul-General Guenther of Frankfort.*

2½ AND 3 FOOT RADIAL DRILL.

The radial drill illustrated herewith is of new design throughout. It is adapted for a medium class of work, and has a capacity for drilling holes from the solid up to 2 in. in steel and 2½ in. in cast iron. One of the most important improvements is the speed box, which, without back gears or a clutch of any kind, gives instantly with a single lever any one of six changes of speed.

Referring to the diagram showing a section through the speed box: C is the driving shaft, to which is keyed the fixed gear D and the sliding gear B; the tumbler plate A on this shaft carries the intermediate gear E, which meshes with B and with any one of the fixed gears, G, H, I, J and K, on the shaft L. The intermediate gear F transmits continuous motion from the fixed gear D to the loose gear M, which carries a pawl and runs on the hub of a ratchet keyed to the shaft L and a device for automatically engaging the pawl or keeping



2½ AND 3-FOOT BICKFORD RADIAL DRILL.

it away from the ratchet. The slowest speed is obtained by sliding the tumbler plate A to the last notch on the right when the intermediate gear E occupies the space between gears K and M, and power is transmitted to the shaft L through gears F and M. Moving the tumbler plate A to the next notch brings the intermediate gear E into mesh with gear K and causes the ratchet on the shaft L to disengage from the pawl in gear M. The shaft L is always in operation; the moment its speed drops below that of the gear M the pawl in the gear acts automatically and keeps it turning until the gear B is again made the driver. As the minimum peripheral speed of the smallest driving gear G is but 182 ft. less than the peripheral speed of the driving gear B, the shock which usually accompanies the engaging of gears broadside, is reduced to a minimum and is absorbed by the belt. The shaft C runs at 350 revolutions per minute, and the highest peripheral speed of any gear in the box does not exceed 301 ft. per minute.

TABLE 1.—LIST OF SPEEDS.

No. Revolutions per Minute Made by Spindle.	Diameter Drills for which Speeds are Suitable.	No. of Feet per Minute at which Drilling is Done.	No. of Feet per Minute at which Drilling Should be Done.
265.09	½	34.60	35.0
209.86	⅝	34.34	34.3
173.68	¾	34.10	33.6
143.91	⅞	33.07	32.9
122.84	1	32.16	32.2
104.29	1⅛	30.72	31.5
95.41	1¼	31.22	30.8
75.53	1½	29.66	29.4
62.51	1¾	28.74	38.0
51.79	2	27.12	26.6
44.21	2¼	26.04	25.2
37.56	2½	24.56	23.8

The speed box in connection with the back gears on the head furnishes the machine twelve changes of speed, the range and gradations of which are shown in Table 1.

A comparison of the figures in the first three columns indicates that the manufacturers have exercised great care in the selection of the gears, as in no instances does the cutting speed vary from the theoretical one by more than .84 of a foot per minute.

An interesting fact, which is very nicely illustrated in Table 2, which was furnished us by the manufacturer, is that speeds which are in true geometrical progression are not by any means the best ones to be used on a machine tool of this kind

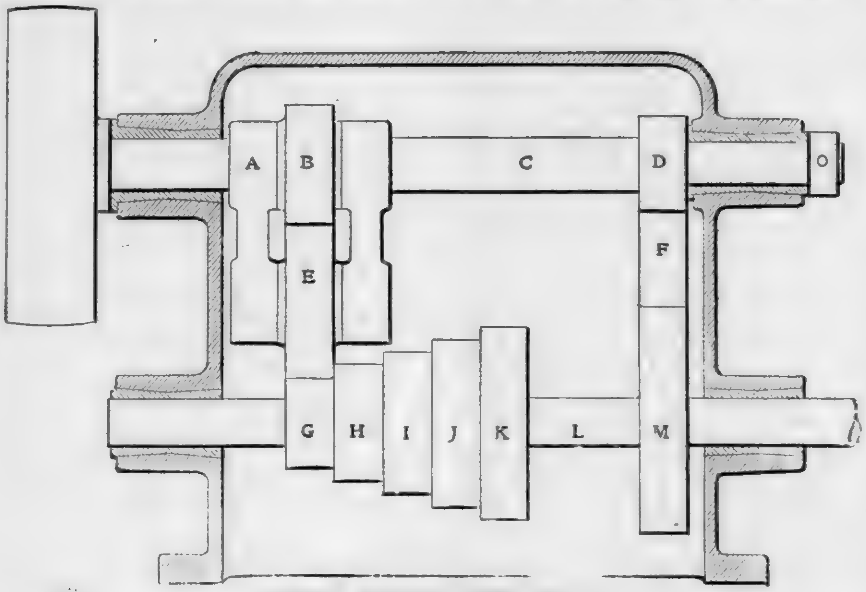
An inspection shows that instead of giving a series of cutting speeds, as shown in Table No. 1, in which no speed is more than .84 of a foot too high, nor .78 of a foot too low; the cutting speeds in the geometrical series vary from 2.88 too high to .92 of a foot too low; in one case the maximum error is but 2.47 per cent. and the average error but .834 per cent., while in the other the maximum error is 8.57 per cent. and the average error 3.903 per cent., or more than four times greater.

TABLE 2.—SPEEDS IN TRUE GEOMETRICAL PROGRESSION.

Geometrical Series.	Diameter of Drills.	Periphery Speeds.
265.09	½	34.60
221.90	⅝	36.31
185.81	¾	36.48
155.54	⅞	35.63
130.26	1	34.10
109.04	1⅛	32.12
91.31	1¼	29.88
76.43	1½	30.01
64.00	1¾	29.32
53.60	2	28.06
44.85	2¼	26.41
37.56	2½	24.56

The back gears consist of three gears and a clutch, located

on the head, and they may be engaged or disengaged from the front of the machine while it is running. The feeding mechanism furnishes four rates of feed, advancing by even increments from .008 to .020 in. per revolution of the spindle, each of which is instantly available. The sleeve is mounted on a stationary stump which extends up to and has a bearing at the top of the machine. By means of steel tumbler gears the arm is lowered at double the speed at which it is elevated. The tapping mechanism is incorporated in the head and allows the taps to be backed out at any speed with which the machine is provided. It is equipped with a friction clutch, which, owing to the back gears being located between it and the spindle gear, is obliged to transmit but one-sixth the pull required at the spindle. These machines are made in 2½ and 3 ft. sizes, which weigh 3,620 and 3,750 lbs. respectively, and are manufactured by the Bickford Drill & Tool Company, Cincinnati, Ohio.

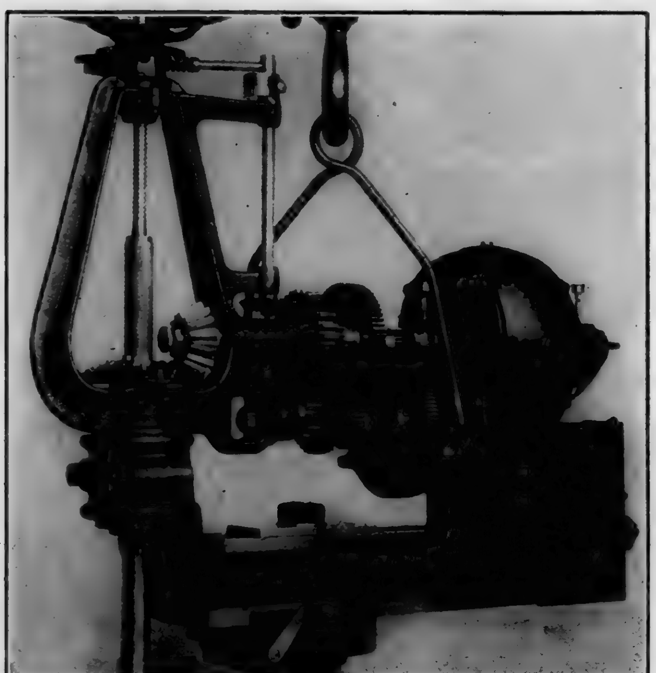


SECTION THROUGH SPEED BOX.

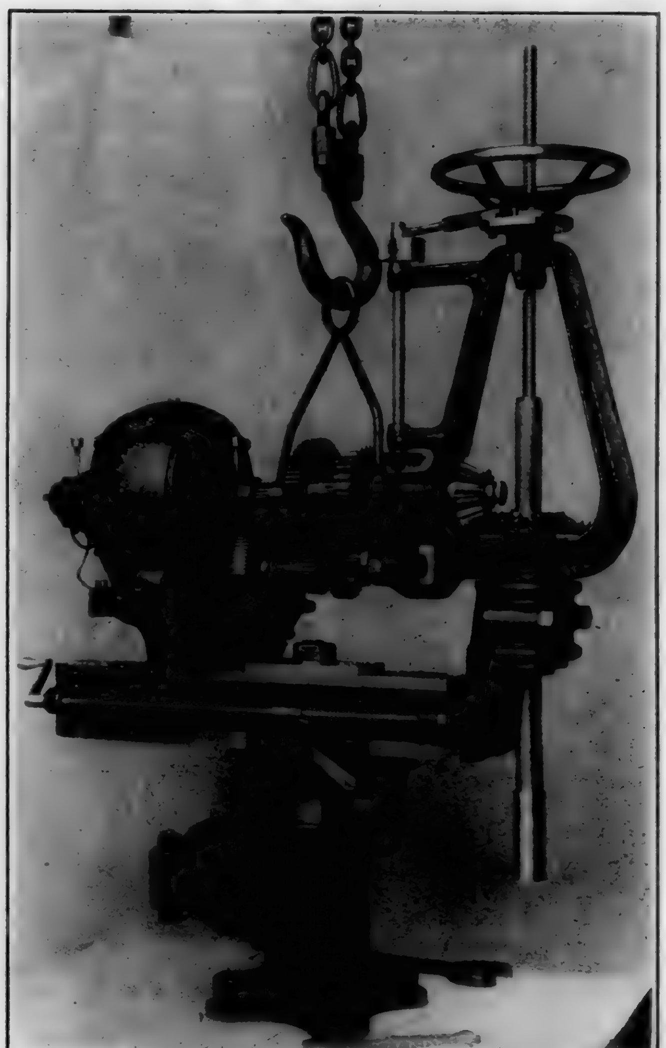
ELECTRIC DRIVEN PORTABLE DRILLS.

For several years Dallett portable drills have been adapted for motor drive, using a special motor and a planetary gear reduction. At the present time, however, they are redesigning their entire line of portable drills, adapting them for motor drive, using standard motors, and machines Nos. 4 and 5 are now upon the market. These machines are provided with a sling for convenient handling by crane, and are extensively used where a portable drill is required for doing heavy or awkward drilling or boring. They are also adapted for a large range of regular work when not employed for portable purposes, and as these two sizes are powerfully back geared, they will do practically the same work as may be accomplished by the use of a large standard drill press or radial drill. Their capacity for different purposes is limited only by the ingenuity of the operator in adapting them to various situations and uses.

The illustrations show a No. 5 machine equipped with a 3-h.p. variable speed Northern Electric 220-volt motor. The general design of No. 4 is practically the same. These drilling machines have a base containing two bearings, one vertical and one horizontal, allowing the machines to be used for either vertical or horizontal drilling. The base is provided with four slotted lugs, by which it can be bolted on or near the piece to be drilled or bored. In this base is fitted a post adjustable to allow for the use of different lengths of drills and sockets in the spindle. On this post, on top of which is cut a worm wheel, is fitted a cup washer containing on one side a bearing with a worm which meshes in the worm wheel on the post by which it can be entirely revolved around the axis of the base.



PORTABLE DRILL, SHOWING APPLICATION OF MOTOR AND STARTING BOX.



ELECTRIC-DRIVEN PORTABLE DRILL.

The frame of the machine rests in a groove planed across the top washer, and is clamped firmly in place by a square washer on top and a stud tapped into the post. This frame has a movement lengthwise at right angles to the axis of the base, is actuated by a side screw, and has at its front end a clamp bearing to receive the drill head. The drill head consists of a frame with a spindle, feed screw and feeding device. The feeding mechanism consists of a pair of bevel gears, feed-shaft, rocker, pawl, ratchet, pawl-plate, wheel, feed nut and feed screw, the latter pressing directly upon the top end of the spindle, the thrust being taken by a fibre-washer, and is coupled to the spindle by a yoke-nut. The connecting rod between the crank and rocker pawl is fitted with a spring, which may be set for any pressure of feed, so that when this pressure is exceeded the spring will be compressed and the feed will cease to operate until the excessive pressure is relieved. A change of feed from one tooth to seventeen is effected by shifting a thumb-latch, no wrench being required. The back gear is thrown in mesh by an eccentric shaft, which is locked in place with a thumb screw. When the back gear is in use the key is unclutched from the cone shaft by throwing out a clutch key.

No. 5 portable drill has a radial adjustment of 26 ins., drilling at one setting anywhere over a surface of 72 ins. outside diameter and 22½ ins. inside diameter. The spindle is provided with a No. 5 Morse taper, has a diameter of 2 1-16 ins., a traverse of 20 ins., and the range of speeds is from 19 to 90 r.p.m., with a feed of from .005 ins. to .075 ins. per revolution of the spindle. The net weight of the machine, complete, is 1,300 lbs.

The No. 4 drill has a radial adjustment of 28 ins., drilling at one setting anywhere over a surface of 56 ins. outside diameter and 16 ins. inside diameter. It has a spindle traverse of 12 ins., with a diameter of spindle of 1 11-16 ins., and is provided with a No. 4 Morse taper. This machine has a range of speed from 29 to 153 r.p.m., with the same feeds per revolution of spindle as the No. 5. The vertical adjustment of the post in the base is 6 ins., as against 8 ins. in the No. 5 machine. The net weight of the No. 4 machine is 765 lbs. These machines are made by the Thomas H. Dallett Company, Philadelphia, Pa., and they expect in a short time to be prepared to furnish any of the other sizes of their drilling machines equipped for standard motors.

BOOKS.

The *Mechanical World* Pocket Dairy and Year Book for 1906. Published by Emmott & Co., Ltd., 118 Chancery Lane, W. C., London. Price, sixpence, net.

This little volume contains over 250 pages of useful engineering notes, rules, tables and data, and, in addition, has about 50 pages for a diary and memoranda for 1906.

Faulty Diction or Errors in the Use of the English Language and How to Correct Them. By Thos. H. Russell, LL.B. 150 pages. Published by Geo. W. Ogilvie & Co., Chicago, 1905. Bound in Russia leather, 50 cents; bound in cloth, 25 cents.

This little book is invaluable to those interested in the correct use of the English language. It considers briefly and to the point common errors of grammar, of construction or faulty rhetoric and unauthorized words which are commonly used. Pronunciation is indicated by careful re-spelling without the use of diacritical marks, which are confusing to those not familiar with their meaning. The book is of "vest-pocket" size.

Proceedings of the American Railway Engineering and Maintenance of Way Association. Sixth annual convention held at Chicago, March, 1905. Published by the Association, 1562 Monadnock Building, Chicago, Ill.

Fourteen of the standing committees presented reports and these, with the discussions, cover about 800 pages. The Committee on Buildings presented a number of recommendations relative to the requirements of a modern roundhouse. These recommendations favor the circular type, although considerable discussion was caused by a plan presented by Mr. D. MacPherson, of the Canadian Pacific, for a rectangular shed for 38 engines, each one of which can enter or leave the shed without shunting any other engine.

Practical Planer Kinks for Planer Hands. By Carroll Ashley. Published by the Hill Publishing Company, New York, 1905. 80 pages. Price, $1.00.

This book was written for planer hands by a planer hand who understands planer work and knows how to tell about it. After a brief description of the planer and some good advice to the operator, the tools, fixtures and clamps are considered. The rest of the book is devoted to the care and operation of the planer and to the best methods of handling various classes of work. It is profusely illustrated.

Physics. By Charles Riborg Mann and George Ransom Twiss. Published by Scott, Foresman & Company, Chicago, Ill., 1905. 450 pages. Price, $1.25.

Physics is a most interesting and important science, and yet how often, as we glance over the pages of a text book, are we impressed with the dry and uninteresting manner in which it is presented. The treatment in the above volume is radically different from the usual method and is interesting and attractive, as well as scientific. The style is simple and informal, and physical, rather than mathematical, arguments are used. A large proportion of the 238 illustrations are half-tone reproductions, showing practical every-day illustrations of the various principles. The book is primarily intended for a high school text book, but is equally well adapted to the needs of those who wish to take up the study of this subject by themselves. It contains no mathematics other than simple arithmetic and the simplest principles of algebra and geometry, and even these are not necessary to a comprehension of the greater part of the book. The treatment is such as to attract the student and to develop and foster the habit of scientific thinking. This book fills a long-felt want and will be found very valuable by those intending to take up the study of physics.

PERSONALS.

Mr. Robert O. Ferran has been appointed assistant foreman of engines of the Pennsylvania at Blairsville, Pa.

Mr. Milton McCara has been appointed machine shop foreman of the St. Louis Southwestern Railway Company, at Pine Bluff, Ark.

Mr. Max Toltz, who is acting in the capacity of consulting engineer for the Hill System, sailed for Europe the early part of November.

Mr. G. A. Bowers has been appointed master mechanic of the Wrightsville & Tennille, with office at Tennille, Ga., to succeed Mr. Lewis Archer, resigned.

Mr. H. H. Harrington, general foreman of the Erie Railroad at Susquehanna, Pa., has been appointed master mechanic to succeed Mr. W. H. Wilson, resigned.

Mr. Arthur C. Colson has been appointed master mechanic of the Dunkirk, Allegheny Valley & Pittsburg at Dunkirk, N. Y., to succeed Mr. Clarence A. Sherman.

Mr. B. H. Hawkins has been appointed master mechanic of the Delaware, Lackawana & Western at Buffalo, N. Y., succeeding Mr. F. W. Williams, resigned.

Mr. W. L. Garland has been appointed assistant general foreman of shops of the Pennsylvania Railroad at West Philadelphia, Pa., succeeding R. T. Garland, deceased.

The title of Mr. W. F. Ackerman, master mechanic of the Chicago, Burlington & Quincy, lines west of the Missouri River, at Havelock, Neb., has been changed to superintendent of shops.

Mr. John H. Ford has been appointed general car foreman and Mr. William H. Walker general foreman of shops and roundhouse, of the Lehigh & New England, with offices at Pen Argyl, Pa.

Mr. W. E. Knight, formerly assistant superintendent of motive power of the United Railways of Havana, has been appointed superintendent of motive power of the Cuba Railroad Company.

Mr. W. H. Wilson has been appointed superintendent of motive power of the Buffalo, Rochester & Pittsburg, with headquarters at Du Bois, Pa., vice Mr. E. E. Davis, resigned.

Mr. J. Kastlin has resigned his position as master mechanic of the St. Joseph Division of the Chicago, Burlington & Quincy Railway to become superintendent of the Davenport Locomotive Works, Davenport, Ia.

Mr. C. H. Burk, formerly master mechanic of the Mexican Central Ry., at Mexico City, has been appointed master mechanic at Chihuahua, to succeed Mr. W. J. Wilcox resigned. Mr. L. Strom succeeds Mr. Burk at Mexico City.

Mr. T. B. McCarthy, who recently resigned as general foreman of shops of the Southern Pacific at Ogden, Utah, has been appointed machine shop foreman at the Pittsburg works of the American Locomotive Company at Allegheny, Pa.

Mr. L. Strom has been appointed master mechanic of the Mexican Central at Mexico City, Mex., succeeding Mr. C. H. Burk, who has been transferred to Chihuahua, Mex., as master mechanic, to succeed Mr. W. J. Wilcox, resigned.

Mr. E. A. Williams, assistant general manager of the Erie, has been appointed general mechanical superintendent of that road and its allied and controlled lines, including the Cincinnati, Hamilton & Dayton, Pere Marquette and Chicago, Cincinnati & Louisville with office at 21 Cortlandt street, New York.

Mr. W. G. Hodgkinson has been appointed roundhouse foreman of the Lake Shore & Michigan Southern at Collinwood, O., in place of Mr. W. F. Kuhn, who has been appointed roundhouse foreman of the Dunkirk, Allegheny Valley & Pittsburg at Dunkirk, N. Y.

Mr. Max Howard Miner, a member of the editorial staff of the *Railway Age*, died November 7th, at the age of 29 years, after a brief illness, at his home in Brooklyn, N. Y. Mr. Miner, thus suddenly taken from that which he had determined to make his life work, was a young man of a rare kind. Endowed with a deep and joyous sense of humor, nevertheless, he took life seriously and believed in his work, finding in technical journalism an opportunity to uplift and advance many with whom he never came personally in contact. He was a painstaking, thorough student, and combined qualities which had already made him a factor in the current progress of railroad development, promising to become stronger and more influential as experience broadened and developed him, and extended the field of his efforts. He considered his work as most truly a profession, and his greatest pleasure came from a worthy task well accomplished. After graduation from Sibley College, Cornell University in 1899, he served as special apprentice in the motive power department of the Illinois Central Railroad for one year. In January, 1901, he became a member of the instructing staff at Cornell and continued as instructor until December, 1901, at which time he joined the editorial staff of the *Railway Age*. His work on that paper was of the highest order, and he was rising rapidly in the technical newspaper field when his sudden illness, apoplexy, overtook him.

Mr. Albert J. Pitkin, president of the American Locomotive Company, died at his home in New York City, November 16, after an illness of several months, the serious character of which was not appreciated or widely known among his closest friends. As the head of one of the greatest industrial organizations Mr. Pitkin's leadership extended in circles which are international in their scope. He was thorough, conscientious, enthusiastic, and his personality inspired his associates and subordinates to their best efforts. His leadership and his influence, combined with his ability, integrity, uprightness of character and unswerving devotion to duty, brought success as a matter of course. The high position which the Schenectady Locomotive Works attained among industrial establishments, was chiefly the result of his high ideals and earnest, unceasing efforts. As the managing head of these works he exerted an influence which reached far beyond the locomotive itself. Many improvements in motive power matters and methods originated with him, and he was deeply concerned in an effort to uplift and uphold the locomotive and motive power management. As an argument he often said: "The locomotive earns every dollar brought into the treasuries of railroads. It, therefore, merits the best attention railroad men can give it."

Mr. Pitkin was born at North Hampton, Ohio, in 1854. At the age of 17 he entered apprenticeship in the stationary engine works of the Webster, Camp & Lane Machine Company of Akron, Ohio. He spent a year in the locomotive repair shops of the Cleveland, Akron & Columbus Railroad, after which he entered the drawing office of the Baldwin Locomotive Works, for which he had prepared by diligent evening study. From this time he gave his attention to locomotive work. After five years at the Baldwin Works he became chief draughtsman of the Rhode Island Locomotive Works, and two years later, in 1882, was appointed mechanical engineer of the Schenectady Locomotive Works. In two years he became superintendent of the works. Upon the death of the president, Edward Ellis, Mr. Pitkin was made vice-president and general manager, and from that time developed the commercial, as well as the manufacturing features of the business which gave these works their high standing among the locomotive building companies of the country. Upon the formation of the American Locomotive Company Mr. Pitkin naturally became its first vice-president, and upon the death of Mr. Callaway, on June 1, 1904, Mr. Pitkin was made president. He never lost the impress received in the home of his father, a Presbyterian Home Missionary in Illinois, and his life was that of a consistent Christian man.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

RADIAL DRILLS.—Circular No. 1A, from the Bickford Drill & Tool Company, Cincinnati, Ohio, is devoted to their new 2½ and 3 ft. radial drills, which are adapted for a medium class of work, and are described on another page of this issue.

DRAW BAR ATTACHMENTS.—A handsomely illustrated catalog, from the Butler Draw Bar Attachment Company, Cleveland, Ohio, is devoted to a description of the Butler draw-bar attachments and a number of drawings are presented, showing various applications.

MACHINE TOOLS.—The Progress Reporter, No. 9, published by the Niles-Bement-Pond Company, 111 Broadway, New York, illustrates a number of new machine tools, several of which are suitable for railroad shops. Four pages are devoted to the Niles electric traveling hoists.

COAL HANDLING MACHINERY.—Catalog No. 20 from the Jeffrey Manufacturing Company, Columbus, O., contains 142 pages and is largely devoted to illustrations showing the installation of their coal handling machinery in mines and illustrating the various details of this machinery.

ELECTRICAL APPARATUS.—Bulletin No. 61, from the Crocker-Wheeler Company, Ampere, N. J., is devoted to the large sizes of their belt-type direct-current machines. The cut-off blade starters used in connection with machines of this type are also described and illustrated in detail.

BALL AND ROLLER BEARINGS.—Catalog No. 12, from the Standard Roller Bearing Company, Philadelphia, Pa., contains 88 pages and is devoted to a detail description of their various types of ball and roller bearings, and also illustrates a number of typical applications of these bearings.

MECHANICAL DRAFT.—WHAT IT IS.—WHAT IT DOES.—This is the title of a neat little folder received from the B. F. Sturtevant Company, Hyde Park, Mass., which briefly presents the salient features of their mechanical draft system and presents several small views, showing various applications.

Steam Engines.—Catalog W. M. 7004, from the Westinghouse Machine Company, East Pittsburg, Pa., is devoted to a description of their standard engine, many of the important features of which are described and illustrated in detail.

Union Pacific Motor Cars.—Under this title the Union Pacific has issued a folder which is devoted to a description of motor cars Nos. 1 and 2, and contains some interesting information concerning the performance of these cars.

Electric Motors for Machine Tools.—Circular No. 15 from the Electro-Dynamic Company, Bayonne, N. J., is devoted to the power required by various machine tools. Circulars 16 and 17 are devoted to the advantages and the design of the inter-pole variable speed motor and its application to machine tools.

Rock Drills.—Catalog No. 18 from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, covers very completely and in detail their line of rock drills for quarry and mining work. Announcement is made of the fact that they have acquired the selling rights of the well-known McKiernan rock drills.

Buda Products.—The Buda Foundry & Mfg. Company, Railway Exchange, Chicago, have sent out a unique folder. On one side is a front view of a locomotive rushing through darkness at a high speed; opening the folder throws a semaphore signal to the danger position and forcibly calls attention to a signal advantage obtained by dealing with the Buda Company.

Foreign Locomotives.—The Baldwin Locomotive Works, Philadelphia, Pa., have issued "Record of Recent Construction," No. 54, which is devoted entirely to various foreign locomotives recently built by them. The frontispiece shows the Mallet compound, which was described on page 183 of our May issue, pulling a long train of gondola cars on the American Railroad of Porto Rico.

Grip the Heart of Things in Draft Gear.—Under this title the Farlow Draft Gear Company, Baltimore, Md., have issued a very interesting pamphlet which considers the essentials of a satisfactory draft gear, and incidentally describes the Farlow gear. This book was intended primarily to appeal to mechanical engineers, and is worthy of close study by those interested in the draft gear problem.

Electric Lighting.—Two well illustrated and nicely arranged bulletins, describing the axle light system of electric lights and fans for railway passenger cars have been received from the Consolidated Railway Electric Lighting & Equipment Company, 11 Pine Street, New York. The first one is devoted to a general description of the axle light system, its operation and advantages. The second bulletin contains general instructions for the installation of this equipment.

Hydraulic Accumulators.—The Watson-Stillman Company, 46 Dey Street, New York, are sending out a new catalog, No. 67, which is devoted entirely to hydraulic accumulators and fittings. This is probably the first catalog of this kind that has ever been issued. It describes the various types of hydraulic, hydro-pneumatic and steam hydraulic accumulators made by them, together with the various attachments and valves which are used in connection with the accumulators.

NOTES.

Wm. B. Scaife & Sons Company.—This company of Pittsburgh, Pa., have been awarded the contract for a large steel frame building to be erected at Economy, Pa., for the National Metal Moulding Company.

American Blower Company.—In order to adequately care for continually increasing business this company of Detroit is erecting a three-story addition to its plant. This addition is rendered necessary by the growing popularity of their type "A" enclosed, vertical, self-oiling engine which was placed upon the market two or three years ago. The building will be of steel and brick construction. The first floor will be used for erecting and testing engines, a very complete new outfit being put in for the latter purpose. The power from engines under test will be absorbed by generators and air compressors. An electric crane will form part of the equipment. The second floor will be used for storing engine parts and painting the completed engines, and the third floor will be utilized for storage purposes entirely.

Duff Manufacturing Company.—This company of Pittsburg, Pa., was awarded a gold medal, highest award, on the Barrett track and car jacks at the Lewis & Clark Exposition, Portland, Oregon. The Barrett jacks were also awarded a gold medal at the Louisiana Purchase Exposition, St. Louis, 1904. It is said these jacks have been adopted as a standard for track and car work by practically every prominent railroad in the United States, as well as in many of the foreign countries.

The Rail Joint Company.—The Rail Joint Company was organized recently by filing at Albany, N. Y., a certificate of incorporation, with a capital stock of $1,500,000, of which $1,000,000 is common stock and $500,000 preferred stock. The officers of the company are: President, Frederick T. Fearey; vice-presidents, Lawrence F. Braine and Percy Holbrook; treasurer, Fernando C. Runyon; secretary, Benjamin Wolhaupter. This company will take over the business and properties of the Continuous Rail Joint Company of America, the Weber Railway Joint Manufacturing Company and the Independent Railroad Supply Company.

The Crandall Packing Company.—This company of Palmyra, N. Y., have for some time been considering opening an Ohio office and the increasing demands of their trade have at last forced them to establish a branch at Cleveland. They have secured a store at 9 South Water Street, and have stocked it with one of the largest and most complete stocks of packing to be found in the city, and have placed in charge Mr. John M. Chapman, who for many years has been the manager of the Cleveland branch of the Garlock Packing Company. Mr. Chapman will be glad to meet all his friends at his new location, and his many years of experience in this line bespeaks a successful outcome of this new undertaking of the Crandall people. Mr. Chapman expects to make this branch office the headquarters for the engineers in his territory, and the combination of a good man and a good packing should prove a winner.

Bucyrus Company.—Mr. Carl A. Strom has resigned the position of superintendent of motive power and machinery for the Isthmian Canal Commission at Panama and accepted the position of works manager of the Bucyrus Company, South Milwaukee, Wis. Mr. Strom is well known as the former mechanical engineer of the Illinois Central R. R. with headquarters in Chicago, who resigned that position in May, 1904, to accept a similar position with the Isthmian Canal Commission. He was the first engineer under the Commission to go to Panama, having preceded Mr. Wallace by a month. He found the shops of the old French Company after twenty years' idleness, practically buried in the jungle, in a generally dilapidated condition and inside of a year's time Mr. Strom had four shops in complete commission and had overhauled and put in service over 75 of the Belgian locomotives and hundreds of the French cars. Considering the conditions of labor, the delay in receipt of material, and the general difficulties encountered, his work there has been recognized as phenomenal, and the conditions required just such physical and mental energy and ability as he possessed.

Industrial Engineering.—Crocker-Wheeler Company, manufacturers and electrical engineers announce the establishment of an industrial engineering department, in which is concentrated all their work in the line of industrial engineering as applied to railway shops, machine shops, and industrial plants of every description. This company was among the first to recognize that high-class electric motors and generators should be accompanied in every case with sound engineering advice to the purchaser. Each sale of a motor has meant with them that a motor-drive problem has been successfully solved by a group of engineering experts. The company are not only "manufacturers" but "electrical engineers." Among those who have availed themselves of the services of Crocker-Wheeler Company in this line are the Lake Shore & Michigan Southern Rd., John Simmons Company, Bucyrus Company, Ansonia Brass & Copper Company, American Bridge Company, Pittsburg & Lake Erie Rd., Joseph Dixon Crucible Company, Ingersoll-Sergeant Drill Co., etc. Mr. J. K. Warner Davenport, E. E., formerly a consulting engineer making a specialty of industrial work, has become associated with the company in order that its growing activities along these lines may be handled in as thorough and satisfactory manner as heretofore. Mr. Davenport and his staff of assistants are at the present time giving personal attention to several important industrial propositions.